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PM(sub 10) and Fugitive Dust in the Southwest - Ambient Impact, Sources and Remedies

PEI Associates, Inc., Golden, CO

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16. ABSTRACT

A study of possible PM_{10} non-attainment sites was conducted by Pace and Hanks of the U.S. EPA in 1984. This investigation showed that about half of these sites are in areas having less than 20 inches of precipitation per year. Also, 10 percent of the sites were in dry rural areas with no apparent traditional sources nearby. The purpose of this project is 1) determine the nature of the sources having an impact on these sites, 2) determine to what extent meteorology plays a role in high measured particulate matter concentrations, and 3) develop possible remedies to a potential non-attainment situation in areas with little rainfall.

This report presents the results of three analyses that were designed to answer these questions. A microinventory was performed on 20 sites. These sites were then compared to sites in the US EPA's IP Network and similarities and differences were analyzed. An evaluation of the relationship between meteorological variables and measured concentrations was made. The report discusses the results of these analyses and alternate control remedies to high concentrations in fugitive dust areas.

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PM10 And Fugitive Dust In The Southwest—Ambient Impact, Sources And Remedies

By

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Golden, CO 80401

Contract No. 68-02-3512

EPA Project Officer
Thompson G. Pace

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office Of Air And Radiation
Office Of Air Quality Planning And Standards
Research Triangle Park, NC 27711

July 1985

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SECTION 1

INTRODUCTION

A previous study investigated the ambient monitor sites with a high probability of exceeding a particulate matter (PM_{10}) National Ambient Air Quality Standard (NAAQS) (EPA 1984). Approximately one-half of these sites are in areas having less than 20 inches of precipitation per year. Also, 10 percent of the sites were in dry rural areas with no apparent traditional sources nearby. The purpose of this project is 1) determine the nature of the sources having an impact on these sites, 2) determine to what extent meteorology plays a role in high measured concentrations, and 3) develop possible remedies to a potential non-attainment situation.

For an answer to these questions, three analyses were performed. Described in Section 2 are a series of 20 microinventories wherein sources within a 1-mile radius of 20 monitors were inventoried in detail. Section 3.0 contains an analysis of similarities and differences between Inhalable Particulate (IP) Network Sites and other sites microinventoried. Section 4.0 includes an evaluation of the relationship between meteorological variables and measured concentrations. Section 5.0 contains a discussion of alternate control remedies.

Sections 2 through 5 provide background information, and answers to the three study questions are presented in Section 6.

SECTION 2

SITE SURVEYS

A total of 31 particulate monitoring sites were specified by U.S. Environmental Protection Agency (EPA) for field surveys. Of these sites, 20 were microinventoried. The 11 drive-by site were not microinventoried. The primary purpose of these site visits was to evaluate the monitor siting and localized particulate sources of each. The monitoring sites are listed in Table 1 and shown (by TSP and PM_{10}) on Figure 1.

MICROINVENTORIES

The microinventory procedure used for this study has been used in various parts of the Nation over the last 6 years (PEDCo Environmental, Inc., 1979a, 1979b, 1979c, 1979d, 1979e, 1979f). This study, however, marks the first time these techniques have been applied to PM_{10} sources.

The survey procedure used at the 20 sites was to survey (via automobile) all probable sources of particulate emisssions within a 1-mile radius of each of the sampling sites. Point and area sources of particulate emissions were located on maps during the ground survey. The maps were labeled with pertinent data such as size and boundaries of the source, observed activity and operational characteristics, and estimated emission rates. Two observers independently estimated and agreed upon parameters observed at each source to enhance accuracy and completeness. The exact procedures followed in the microinventory are described in Appendix A.

TABLE 1. MICROINVENTORY AND DRIVE-BY SITES

MICROINVENTORY SITES

1. Carefree Airport, Carefree, AZ
2. Canyon Drive, Hayden, AZ
3. 1845 Roosevelt St., Phoenix, AZ
4. 4732 S. Central Ave., Phoenix, AZ
5. 521 10th Ave., Safford, AZ
6. 201 S. 2nd Ave., Yuma, AZ
7. 225 Chester Ave., Bakersfield
8. 815 Main St., Brawley, CA
9. Powerline Rd., China Lake, CA
10. 935 Broadway, El Centro, CA
11. 14838 Foothill Blvd., Fontana, CA
12. 3021 Manor St., Oildale, CA
13. 588 Mission Blvd., Rubidoux, CA
14. Cobre Supply, Bayard, NM
15. Anthony School, Anthony, NM
16. Grant County Water Dept. Building, Hurley, NM
17. 222 S. Campbell St., El Paso, TX
18. 2616 W. Paisano Dr., El Paso, TX
19. Clint High School, Clint, TX
20. 2935 South, 8560 West, Magna, UT

DRIVE-BY SITES

21. 13665 N. Scottsdale Rd., Scottsdale, AZ
22. 1700 Flower St., Bakersfield, CA
23. 341 First St., Calexico, CA
24. 7002 Magnolia Ave., Riverside, CA
25. Sunland Park Racetrack, Dona Ana County, NM
26. McNutt Rd., Dona Ana County, NM
27. 7862 San Jose Rd., El Paso, TX
28. 2300 San Diego Ave., El Paso, TX
29. 9060 Socorro, El Paso, TX
30. 700 East 2nd South, Pleasant Grove, UT
31. 50 East Main, Lindon, UT

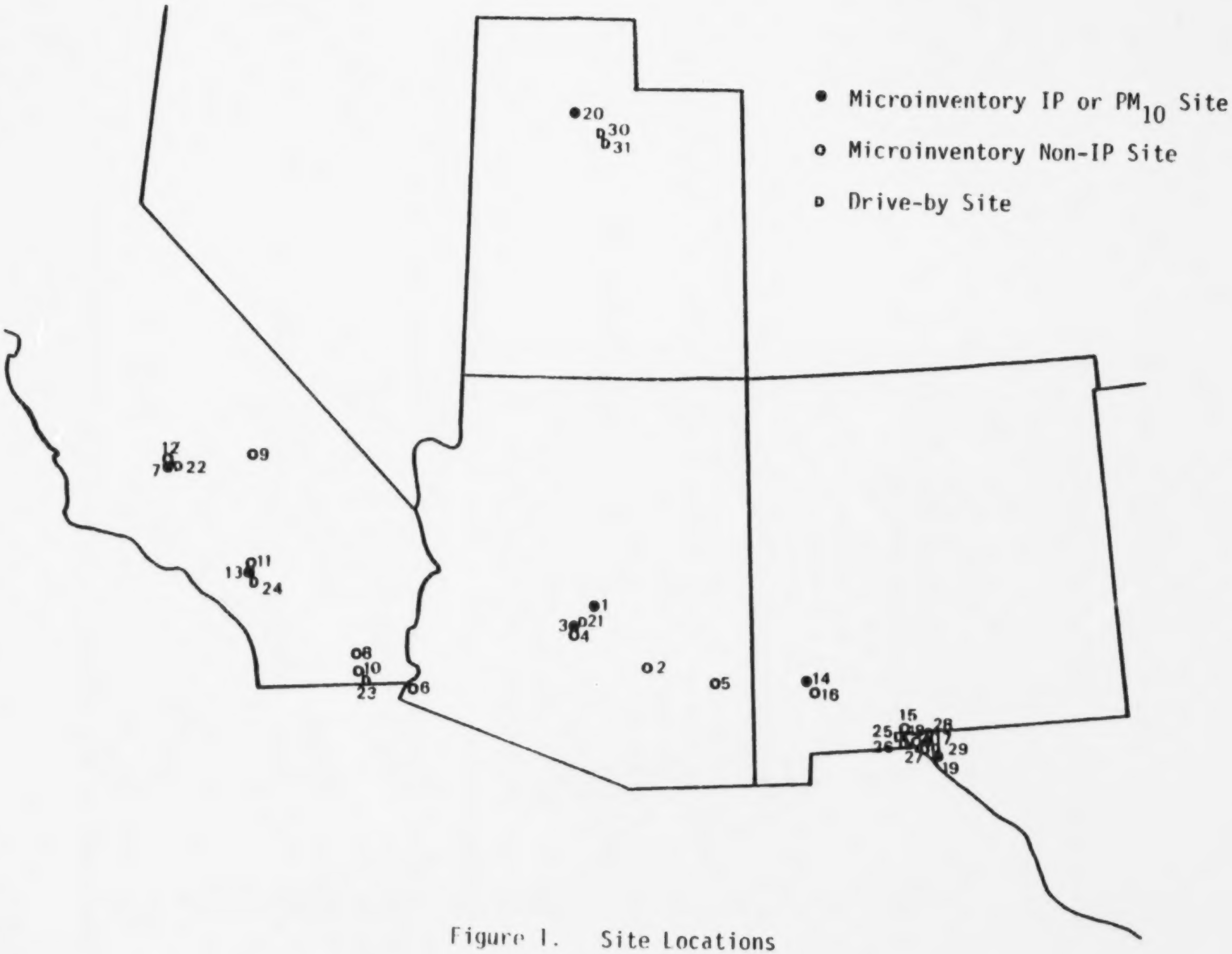

● Microinventory IP or PM$_{10}$ Site
○ Microinventory Non-IP Site
ᴅ Drive-by Site
20
30
31
1
3
21
4
2
5
14
16
15
25
26
28
27
29
19
12
7
22
9
11
13
24
8
10
23
6

Figure 1. Site Locations

Point Sources

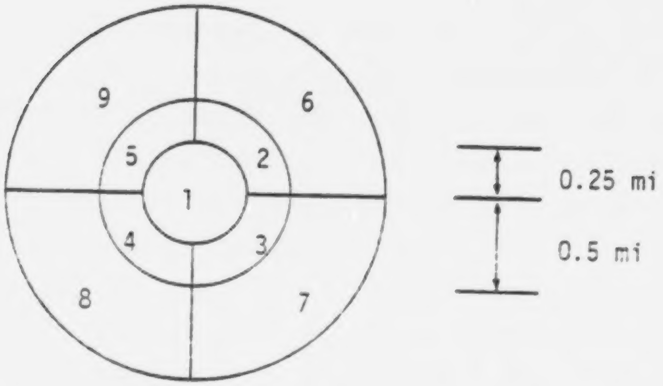
During the ground survey, an attempt was made to locate every significant particulate point source ($\geq$ 1 ton/yr within 1 mile of the monitor). Once identified, annual particulate emissions from industrial sources were obtained from a state or NEDS point source listing. Further, any source listed in the point source file and not identified in the survey was located by using universal transverse mercator (UTM) coordinates and street addresses.

A table of point sources within 5 miles of the monitor was compiled for each sampler site. These sources were compiled from NEDS source listings provided by EPA and source worksheets provided by the appropriate state agency. Only those sources with estimated annual particulate emissions of 25 tons/yr or more were considered to be major point sources unless they were within 1 mile of the monitor. Smaller sources listed in the point source file were considered, but their predicted impact on the monitor was insignificant at more than 1 mile. Estimated PM_{10} emissions from the point sources were calculated from the TSP data by using a recent report that includes a compilation of particle size distributions for a variety of sources (PEDCo 1984a).

Distance and compass direction from the monitoring site were computed for each point source so that source could be assigned to the appropriate wind quadrant as required by the "Empirical Model" procedure (EPA 1979a).

Area Sources

The area to be microinventoried was divided into nine sectors, as shown in Figure 2. All identified fugitive dust sources within the survey area were recorded on the data sheet by sector with estimates of size, location, and activity. Appropriate emission factors were then applied to each source to calculate estimated annual emissions. These emission factors are discussed in Appendix B.



9
6
5
2
1
4
3
8
7
0.25 mi
0.5 mi

Figure 2. Area source sectors in 1-mile radius.

Conventional area source emissions were not included in the ground survey, but they were added to the emissions from state or NEDS files to determine the total area source particulate emissions by sector. Residential and commercial fuel combustion emissions were determined for each sector by apportioning county emission totals by the ratio of sector/county population and area. The county emission totals were obtained from NEDS area source emissions reports. Values used are indicated on the area source summary sheets for each site.

Site Summaries

A multipage summary was compiled for each sampling site inventoried. These site data summaries are presented in Appendix C. The first page of each summary is a complete description of the individual site, including SAROAD code, street address, UTM coordinates, location and height of the monitor, land-use, topography in the vicinity of the site, localized sources within 200 feet of the monitor, and historical air quality data. The sampler site and surrounding 1-mile-radius survey areas are illustrated on the second page. The next two pages summarize the area source emission (both TSP and PM_{10}) for a 1-mile radius about the sampler site. A listing of all the point sources located within a 5-mile radius of the sampler is included on the succeeding pages.

DRIVE-BY SITES

A total of 11 sites were visited but not microinventoried. During each visit, photographs were taken of the monitor siting. Additional photographs were taken in a 360 degree circle around the monitor. The purpose of driving by the 11 sites was to determine if the monitors were correctly sited and if they were directly impacted by a nearby particulate source. Drive-by survey results are shown in Table 2. Five of the 11 sites had major dust sources nearby.

TABLE 2. PROXIMITY OF DRIVE-BY SITES TO MAJOR DUST SOURCES

Site Location	Major emission sources close to site
21. Scottsdale	Exposed areas, construction
22. Bakersfield	None
23. Calexico	None
24. Riverside	Paved roads
25. Sunland Park	Powerplant
26. McNutt Road	Unpaved road, unpaved area, powerplant, concrete batching, smelter
27. San Jose Rd.	Unpaved lot
28. San Diego Avenue	None
29. Socorro Rd.	None
30. Pleasant Grove	None
31. Lindon	None

SELECTION OF APPROPRIATE AIR QUALITY DATA

Because the sites were visited in 1984, the 1983 data were the first choice for the measured air quality data to be used as the dependent variable. Air quality data were available from two sources. A 1982 and 1983 SAROAD listing was obtained for each of the sites. In addition, for the eight sites that were part of the EPA IP sampling network (sites 1, 3, 7, 13, 14, 17, 19 and 20), daily values were available from a previous study for 1979 through 1982 (PEDCo 1984b).

A review of the available data made it apparent that not all the data for each site were appropriate for use. The TSP data for IP network sites and state monitors at the same location were not always consistent, and some data represented insufficient samples for calculation of a valid annual mean. In other cases, the sites were not operational during the years of interest. Consequently, the following hierarchy was established for selection of data for each site:

1. If 1983 TSP data are available and 45 or more samples were taken (75% of possible), use 1983 data.
2. If 1983 TSP data are inadequate, use 1982 TSP data if 45 or more samples were taken. Also, for 1982, if both IP network and state monitoring data are available, use the IP network data (TSP and IP or PM_{10} concentrations) if more than 45 samples were taken.
3. If neither of the above conditions hold, use the year with the most samples from 1981-1983.

Based on this selection process, the TSP and IP data shown in Table 3 were made a part of the data base.

CALCULATION OF PM_{10} VALUES

After selection of the air quality data for each site, equivalent PM_{10} data were derived for each site. For site 13, which has TSP, IP, and PM_{10} measured data, the measured PM_{10} value was used, even though only 36 samples were taken. When

TABLE 3. AIR QUALITY DATA BASE

Site No.	Year	Annual average concentrations, μg/m³			Number of samples		
		TSP	IP	PM_{10}[a]	TSP	IP	PM_{10}
1	1982	46[b]	21	16[c]	43[b]	49	
2	1983	119		56	51		
3	1982	101	54	42[c]	53	43	
4	1982	128		60	61		
5	1983	110		52	56		
6	1983	119		56	53		
7	1981	118[b]	64[b]	49	30[b]	25[b]	
8	1982	145[b]		68	25[b]		
9	1982	26		12	52		
10	1982	123[b]		58	42[b]		
11	1981	143		67	56		
12	1983	108		51	49		
13	1982	130	92	78[d]	45	38	36
14	1983	116	e	54	60		
15	1983	116		54	60		
16	1983	98		46	59		
17	1983	96	e	45	51		
18	1983	139		65	57		
19	1981	67	46	35	50	53	
20	1983	55	e	26	56		
21	1982	71[b]		33	20[b]		
22	1982	112		53	57		
23	1982	166		78	50		
24	1982	110[b]		52	38[b]		
25	1983	89		42	61		
26	1983	112		53	62		
27	1983	192		90	47		
28	1983	60		28	55		
29	1983	121		57	59		
30	1983	55		26	237		
31	1983	58		27	60		

[a] PM_{10} values estimated from TSP data except as noted.

[b] Insufficient number of samples for valid mean according to Criteria 1, Sub-section 2.4

[c] PM_{10} value estimated from IP observations

[d] PM_{10} value obtained from direct measurement

[e] 1983 state air quality data used for TSP; no IP data were available (Criteria 1, Sub-section 2.4).

sites had measured IP data, these data were multiplied by an IP to PM_{10} conversion factor of 0.77 obtained from a recent report (PEDCo 1984b). For those sites with measured TSP data only, a two step process was developed. First, a ratio of the mean IP and TSP concentrations was calculated from simultaneous TSP and IP data observed at the eight IP network sites from 1979 to 1982. For each site, average IP and TSP concentrations were calculated from the data on days for which both measurements were available. The resulting ratios of IP/TSP varied from 0.50 to 0.70. The weighted average ratio (based on sample size) was then calculated to be 0.60. This value agreed well with the previously reported IP/TSP ratio of 0.61 (PEDCo 1984b). Consequently, the 0.61 ratio reported as the national average ratio was used for the TSP to IP conversion. Finally, the 0.61 value was multiplied by the 0.77 PM_{10}/IP ratio noted above to yield a PM_{10}/TSP conversion factor of 0.47. These factors were applied to the measured data in Table 3 to obtain an estimate of PM_{10} for each site.

Because of the limited data base, this method was developed to obtain a PM_{10} value for each site. The use of such multipliers as those listed above (0.77, 0.61, 0.47) is not the procedure recommended in "Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate NAAQS Using Total Suspended Particulate or Inhalable Particulate Data³ (EPA 1984). Their use in this analysis is for demonstrative purposes only and should not be construed as a recommendation for their future use. The reader should refer to the referenced EPA document for recommended approaches.

SECTION 3

EXAMINATION OF SIMILARITIES AND DIFFERENCES BETWEEN IP AND NON-IP SITES

A series of five analyses were undertaken to examine the similarities and differences between sources at non-IP and IP sites. Determining the sources impacting the monitors is helpful for two reasons. First, if the IP and non-IP sites are similar with regard to sources and PM_{10}/TSP ratios, EPA can be confident that conclusions gained from analyzing the IP network data, such as the Probability Guideline (EPA 1984), can be extrapolated to the larger data base of non-IP sites. Second, knowledge of source types causing high measured values directs the focus of control strategies. The five analyses are presented in the following subsections.

EVALUATION OF MEASURED AIR QUALITY COMPARED WITH QUALITATIVE INDICATORS OF SOURCE ACTIVITY

This analysis was performed to determine if the mere presence or absence of certain types of emission sources can be used to explain the intersite variation observed in annual air quality measurements. Based on observations made during the site visits, a list of seven indicators of sources having a potential impact at the monitors was developed. These indicators were split into industrial sources and fugitive dust sources as follows: industrial--smelting, oil, other industrial; fugitive dust--agriculture, exposed areas, unpaved areas, construction. A data base was developed with measured annual concentration listed as the dependent variable and indicators of source activity as the independent variables. These indicators were merely 0 or 1, where the presence of a source category within 1 mile of the monitor was indicated by a 1 and its absence by a 0. The qualitative indicators are shown in Table 4, along with the air quality data base.

The method used to evaluate the data base in Table 4 was stepwise multiple linear regression (MLR). It was available as a computer program as part of the Statistical Package for the Social Sciences (SPSS) (Nie, et al. 1975). The regression program is explained in moderate detail in Appendix D. Further information on this program can be found in the following two references: Statistical Methods, Fourth Edition (Snedecor 1946); Applied Regression Analysis (Draper and Smith 1965). The program first selects the independent variable that is the best predictor for the dependent variable (concentration). The dependent variable values are then changed to reflect the effect of this independent variable. The process is then repeated with the remaining variables until all have been used in the equation or until no improvement in the predictive equation was obtained by adding another variable.

The MLR outputs of greatest interest are the significance of each variable and the portion of the total variation explained by the variables at each step of the regression (R^2). Significance is the probability that the observed relationship between the independent and dependent variables is due to chance. For the purposes of this analysis and the following discussions on other analyses, if the significance was less than 0.05, the variable was considered to be a significant one. If the significance was greater than 0.05, the variable was not considered to be significant. Only those variables deemed significant were included in the final regression equation from the MLR analysis. For each MLR analysis, the significant variables were checked for colinearity. No significant intercorrelations were found for any of the significant variables.

TABLE 4. AIR QUALITY DATA BASE

Site No.	Year	Annual average concentrations, $\mu g/m^3$			Number of Samples			Qualitative variables						
		TSP	IP	PM_{10}	TSP	IP	PM_{10}	Smelter	Oil	Other	Agric.	Exposed	Unpaved	Const.
1	1982	46	21	16	43	49		0	0	0	0	1	1	0
2	1983	119		56	51			1	0	0	0	1	1	0
3	1982	101	54	42	53	43		0	0	1	0	1	1	1
4	1982	128		60	61			0	0	1	0	1	1	1
5	1983	110		52	56			0	0	1	1	1	1	0
6	1983	119		56	53			0	0	0	1	1	1	0
7	1981	118	64	49	30	25		0	1	1	0	1	1	1
8	1982	145		68	25			0	0	1	1	1	1	0
9	1982	26		12	52			0	0	0	0	1	1	0
10	1982	123		58	42			0	0	1	1	1	1	0
11	1981	143		67	56			0	0	1	1	1	1	0
12	1983	108		51	49			0	1	1	0	1	1	0
13	1982	130	92	78	45	38	36	0	0	1	0	1	1	0
14	1983	116		54	60			1	0	0	0	1	1	0
15	1983	116		54	60			0	0	0	1	1	1	0
16	1983	98		46	59			1	0	0	0	1	1	0
17	1983	96		45	51			1	0	1	0	1	1	1
18	1983	139		65	57			1	0	1	0	1	1	0
19	1981	67	46	35	50	53		0	0	0	1	1	1	0
20	1983	55		26	56			1	0	1	1	1	1	0
21	1982	71		33	20			0	0	0	0	1	1	1
22	1982	112		53	57			0	1	1	0	1	1	1
23	1982	166		78	50			0	0	0	1	1	1	0
24	1982	110		52	38			0	0	1	0	1	1	0
25	1983	89		42	61			1	0	1	0	1	1	0
26	1983	112		53	62			1	0	1	0	1	1	0
27	1983	192		90	47			0	0	0	0	1	1	0
28	1983	60		28	55			0	0	0	0	1	1	0
29	1983	121		57	59			0	0	0	1	1	1	1
30	1983	55		26	237			0	0	1	0	1	1	0
31	1983	58		27	60			0	0	1	1	1	1	0

Results

As shown in Table 4, the variable descriptors for unpaved and exposed areas are present at all sites and consequently never entered the MLR equation. For the other variables, the results are as follows:

Step	Variable (in order of output)	R	R^2	Significance
1	Agriculture	0.13	0.018	0.473
2	Other (industrial)	0.17	0.029	0.581
3	Oil	0.17	0.030	0.843
4	Construction (fugitive dust)	0.18	0.031	0.913

None of the other variables entered the regression.

As is evident from the results, this simplistic approach to the description of the source receptor relationship at these sites yields no significant results. An additional computer run was made that eliminated those sites with less than 45 samples. This effort also did not yield any significant results. Therefore, it can be said that the source type descriptors used do not adequately explain the observed variation in air quality between sites.

APPLICATION OF THE "EMPIRICAL MODEL"

The EPA has developed an Empirical Model to relate particulate emissions in an area to ambient air quality (EPA 1979a). The particulate emission data are obtained through a survey technique referred to as a microinventory. In addition to providing the emission data used in the empirical model, the microinventory procedure allowed the observers to become familiar with each site.

The Empirical Model is a multiple linear regression equation with the annual geometric mean particulate concentration as the dependent variable and with four independent variables. The model was derived from microinventory data from 79 sites in four cities (Kansas City, St. Louis, Portland, and Birmingham), which yielded a multiple correlation of 0.88 with the four independent variables. The model is described more fully in Appendix E.

The general form of the equation is:

$$\text{AVGAQ} = 0.00451(\text{AREA}) + 0.0096(\text{POINT}) + 50.5(\text{LOCAL}) + 18.6(\text{VISDT}) + (\text{DPT, DSL, DB, or } 0) + 57.2$$

where AVGAQ = Predicted annual geometric mean, mg/m^3

$$\text{AREA} = \frac{A_1}{0.0324} \; \frac{25}{\text{HGT}} + \frac{A_{2-5}}{0.16} + \frac{A_{6-9}}{0.6084}$$

A_i = Total area source emissions in section i, ton/yr (i = 1 to 9)

HGT = Height of sampler, ft

$$\text{POINT} = \sum_{i-1}^{n} \frac{\text{PSEM}_i}{D_i^{\,2}} (\text{WWF})$$

n = Number of point sources within 5 mi

PSEM_i = Emissions from point source i, ton/yr

D_i = Distance to point source i, mi (lower limit of D_i if 0.25)

WWF = Wind weighting factor computed as wind frequency (%) in quadrant where source is located divided by 25, dimensionless. (The frequency of winds was determined from NWS data taken at the nearest station or a compilation of the two nearest stations' data.)

$$\text{LOCAL} = \frac{\ln \text{ADT}_1}{\text{HGT}^2 + \text{DIS}_1^{\,2}} + \frac{\ln \text{ADT}_2}{\text{HGT}^2 + \text{DIS}_2^{\,2}}$$

ADT_i = Average daily traffic on nearby road i, veh/day

DIS_i = Distance to road i, ft (upper limit of DIS_i is 200)

VISDT = 0 if no visible plume results from passing traffic, 1 if there is a plume

DPT, DSL, DB= Dummy variables to account for different background concentrations in each of the cities relative to Kansas City:
DPT = −21.6 (Portland), DSL = −6.6 (St. Louis),
DB = −6.9 (Birmingham)

The model is appropriate for use in several areas:

1. Determining the impact of a source or source category on ambient air quality.
2. Predicting air quality at locations where there is no sampler.
3. Evaluating the impact of a source or source category on ambient air quality.
4. Evaluating the impact of particulate control measures.

Despite the fact that it was developed for other geographical areas, the model was used in this instance to evaluate its applicability and utility for monitoring sites in the Southwest. This area of the country is substantially drier than those metropolitan areas for which the model was developed. No previous attempt had been made to apply this technique to the Southwest. Consequently, should the technique prove applicable, it would be a useful tool for estimating the relative impacts of the various sources and source categories identified during the microinventories.

TSP

Using the form of the Empirical Model and the TSP microinventory data in Appendix C, predicted concentrations for TSP were calculated for the four independent variables in the equation. These results were summed and then the 57.2 constant term was added. These results are compared with measured air quality data in Table 5.

A simple correlation between measured and predicted air quality yields a correlation coefficient "r" of 0.40. If the five sites with 45 or fewer samples are eliminated, the correlation rises to 0.59. Even with these data points eliminated, the relationship explains less than 35 percent of the variance in the data.

An interesting result presented in Table 5 is the difference in average residual values, wherein the Empirical Model predicted better for the IP sites than for the non-IP sites. Since the Empirical Model was developed for areas with significantly higher amounts of precipitation and for predicting annual geometric mean TSP concentrations, the belief was that performing an entirely new analysis for the 20 sites microinventoried for this study would yield a better TSP Empirical Model for the Southwest region of the country.

TABLE 5. EMPIRICAL MODEL RESULTS FOR TSP

Site	Predicted Concentration µg/m³ AREA term	POINT term	LOCAL term	VISDT term	Predicted conc., µg/m³	Measured conc., µg/m³	Residual, µg/m³	No. of samples
IP Sites								
1	4.3	0	0	0	61.5	46.0	15.5	43[a]
3	48.1	0	12.4	0	117.7	101.0	16.7	53
7	11.7	0.2	10.0	0	79.1	118.2	-39.1	30[a]
13	18.6	0	0	0	75.8	130.4	-54.6	45[a]
14	21.6	0	13.6	18.6	111.0	115.8	-4.8	60
17	25.8	0.1	10.5	0	93.6	95.5	-1.9	51
19	37.2	0	0	0	94.4	67.0	27.4	50
20	7.3	0.9	0	0	65.4	55.1	10.3	56
					Average Residual	-3.8		
Non-IP Sites								
2	48.9	0	12.8	0	118.9	119.2	-0.3	51
4	14.5	0.1	5.7	0	77.5	128.0	-50.5	61
5	18.1	0	3.7	18.6	97.6	110.0	-12.4	56
6	55.6	0	8.8	0	121.6	118.8	2.8	53
8	13.1	0	6.3	0	76.6	145.4	-68.8	25[a]
9	15.7	0	1.9	0	74.8	25.6	49.2	52
10	16.0	0.2	5.7	0	79.1	122.6	-43.5	42[a]
11	12.7	1.8	4.0	18.6	94.3	142.9	-48.6	56
12	6.0	4.6	5.2	18.6	91.6	108.0	-16.4	49
15	30.9	0	0	18.6	106.7	115.6	-8.9	60
16	37.9	0	0	18.6	113.7	98.1	15.6	59
18	62.5	7.0	0	18.6	145.3	139.2	6.1	57
					Average Residual	-14.6		

[a] not a valid year of data

To that end, a data base composed of data extracted from the microinventory summaries was compiled. This data base contained area source emissions by annular sectors, point source emissions by sector and quadrant, wind frequency distributions by quadrant, monitor heights and distances to paved streets within 200 feet of the monitors, ADT on these streets, air quality data, and a visible dust indicator (VISDT = 0 or 1). Procedures followed were those used in the development of the original Empirical Model.

Multiple Linear Regression Results

The MLR program was exercised with the four major terms (AREA, POINT, LOCAL and VISDT) for the 15 sites with valid years of monitoring data (Sites 1, 7, 8, 10 and 13 were excluded; see Table 5). The results of the analyses for TSP are:

Step	Variable (in order of output)	R	R^2	Significance
1	VISDT	0.48	0.23	0.067
2	LOCAL	0.65	0.42	0.072
3	AREA	0.72	0.52	0.168
4	POINT	0.74	0.55	0.490

For PM_{10}, the LOCAL and VISDT terms were identical to those used for TSP; the AREA and POINT terms were calculated by using PM_{10} emissions. The results of the PM_{10} analysis are:

Step	Variable (in order of output)	R	R^2	Significance
1	VISDT	0.50	0.25	0.061
2	LOCAL	0.63	0.40	0.114
3	AREA	0.69	0.48	0.206
4	POINT	0.71	0.50	0.447

The results indicate that none of the variables are significant at the 0.05 level; however, it is interesting to note that the variables entered the equations for PM_{10} and TSP in the same order. Further, the presence of a fugitive dust source with visible emissions (VISDT) is an interesting result; VISDT refers to the presence of a visible dust plume from traffic on a street located within 200 feet of a monitor. This result indicates the importance of the cleanliness of the street near the monitor on measured concentrations.

Although the predictive equations explain only about 50 to 55 percent of the variance in the data (as compared with 77 percent in the original model development analysis), it is interesting to compare the various forms of the equations:

Empirical Model

$$\text{Conc} = 0.00451(\text{AREA}) + 0.00096(\text{POINT}) + 50.5(\text{LOCAL}) + 18.6(\text{VISDT}) + 57.2$$

TSP Equation for this study

$$\text{Conc} = 0.0022(\text{AREA}) + 0.0026(\text{POINT}) + 138.3(\text{LOCAL}) + 34.5(\text{VISDT}) + 55.5$$

PM_{10} Equation for this study

$$\text{Conc} = 0.0018(\text{AREA}) + 0.002(\text{POINT}) + 51.03(\text{LOCAL}) + 15.4(\text{VISDT}) + 27.4$$

The two equations derived from the 15 sites in this study have constant terms similar to those in the original form of the Empirical Model. The LOCAL terms and the TSP VISDT term have much higher constants here, which suggests the relative importance of nearby sources on measured air quality in the Southwest. Similarly, the coefficient for the POINT term is much higher in the derived equations from this study. Finally, the AREA term has much smaller coefficients. In general, these Southwest sites had smaller point source emissions and larger area source emissions than those found at the sites from which the Empirical Model was derived. Consequently, the different coefficients for the AREA and POINT term may be the result of this distribution. This conclusion is supported somewhat by the low significance for these two variables.

It should be noted that these new empirical equations should not be used for subsequent analyses. They are merely illustrative of the methodology that could be used to develop site-specific equations. Further details on this technique and its limitations can be found in the literature (EPA 1979a).

Finally, the emission calculations for the sites microinventoried demonstrate the high level of fugitive dust around these sites, which would be a significant factor in measured concentrations in excess of the proposed PM_{10} standards. Of particular concern are those sites that are located immediately adjacent to unpaved areas.

Concentrations measured at such sites may not be representative for a particular area because of the presence of such localized sources. In cases where few sources exist except one unpaved road, a particular area may be inappropriately classified as nonattainment entirely as the result of the monitor location.

SITE IMPACT SUMMARY AND RELATIONSHIP OF IP TO NON-IP SITES

A summary of relevant site data relating to proximity to emission sources was prepared for the 20 sites that were microinventoried as shown in Table 6. For each site, the air quality data on file were searched for the highest measured 24-h IP concentration for the IP Network sites and the highest 24-h TSP concentration for the other sites. Conversion factors from a recent report were used to convert these measured values to equivalent PM_{10} values as follows (PEDCo 1984b):

$$\text{High 24-h } PM_{10} = 0.78 \text{ (high 24-h IP)}$$

$$\text{High 24-h } PM_{10} = (0.78)(0.75)\text{(high 24-h TSP)}$$

These values were then entered on the table. It should be noted that the use of such multipliers is not recommended in the Probability Guidelines. Also indicated in Table 6 are those sites that did not have an adequate number of samples to represent a valid annual mean concentration, and those sites that had an obvious significant fugitive dust source or major point source in the vicinity of the monitor. Of those sites with a sufficient number of samples from which to compute valid annual arithmetic means, only two (Clint and Bayard) of the five IP Network sites had a nearby emission source. It was apparent at the time of the microinventory that these sources would have a potential large

TABLE 6. INTERSITE COMPARISONS

Site	Location	Estimated conc., µg/m³		Insufficient sample size	Siting issues	Emission sources close to site	
		Annual PM_{10}	High 24-h PM_{10}			Fugitive dust	Point
IP Sites							
1	Carefree	16	53	X	X	Unpaved taxiway	
3	Phoenix-Roosevelt	42	115				
7	Bakersfield	49	152	X			
13	Rubidoux	78	208				
14	Bayard	54	207		X	Unpaved lot	
17	El Paso - Campbell	46	160				
19	Clint	35	141			Agriculture	
20	Magna	26	75				
Non-IP Sites							
2	Hayden	56	308		X	Unpaved haul road	Smelter
4	Phoenix - S. Central	60	150				Sand & gravel
5	Safford	52	167		X	Unpaved alley	
6	Yuma	56	203		X	Unpaved lots & alley	
8	Brawley	68	323	X			
9	China Lake	12	41		X	Dry lake	
10	El Centro	58	208	X			
11	Fontana	67	225		X	Unpaved roads	
12	Oildale	51	210		X	Unpaved alley	Oil fields
15	Anthony	54	216		X	Schoolyard	
16	Hurley	45	169		X	Unpaved lot	Smelter
18	El Paso - W. Paisano	69	300		X	Unpaved roads	Smelter

impact on measured concentrations because of the monitor location. For those monitors without a nearby emission source, measured concentrations are apparently due to any one or all of the following:

- High background concentrations
- Fugitive sources not near the monitor but still impacting the monitor
- Point sources some distance away.

Nine of 10 non-IP sites with valid data had a nearby source that may have contributed to high localized concentrations. This observation is probably one of the most significant findings of this study. Although it cannot be absolutely determined to what extent these monitor locations contributed to high measured concentrations, it is reasonable to assume that the measured concentrations would have been lower had the monitors been sited elsewhere. In this regard, it is interesting to note that for sites with valid data, the high 24-hour PM_{10} concentration is 49 $\mu g/m^3$ higher for non-IP sites than for IP sites.

COMPARISON OF ACTIVITY RATES FOR IP AND NON-IP SITES

Another method of examining possible differences between IP sites and non-IP sites is to examine summary data from the microinventories relating to fugitive sources and point sources. These data are shown in Tables 7 and 8, and differences can be analyzed at three levels: 1) comparison by emission category type, 2) comparison of emissions ratios from IP and non-IP sites, and 3) comparison of PM_{10}/TSP emission ratios to ambient PM_{10}/TSP ratios at selected IP sites.

Comparison of Emission Category Type at IP and Non-IP Sites

Comparison of emission categories between IP and non-IP sites in Table 7 for fugitive area sources indicates that, on average, non-IP sites had 38 and 36 percent more TSP and PM_{10}

TABLE 7. COMPARISON OF EMISSIONS BY SOURCE CATEGORY

Site Name	TSP Emissions, ton/yr				PM$_{10}$ Emissions, ton/yr				PM$_{10}$/TSP Ratio from Micro-inventories	PM$_{10}$/TSP Ratio from Monitoring	PM$_{10}$/TSP Ratio from Microinventories for Fugitive Dust
	Area Sources		Point Sources	Total	Area Sources		Point Sources	Total			
	Fug.	Comb.			Fug.	Comb.					
IP Sites											
1. Carefree, AZ	55.6	0.7	0	56.3	31.4	0.7	0	32.1	0.57	0.35	0.56
3. Roosevelt St., Phoenix, AZ	1717.4	20.1	334	2071.5	937.6	15.0	189	1141.6	0.55	0.42	0.55
7. Bakersfield, CA	525.3	12.3	624	1161.6	308.9	9.4	548	866.3	0.75	0.42	0.59
13. Rubidoux, CA	384.1	28.2	493	905.3	222.0	21.4	307	550.4	0.61	0.60	0.58
14. Bayard, NM	270.3	8.8	0	279.1	150.8	6.9	0	157.7	0.57		0.56
17. Campbell St., El Paso, TX	1248.9	11.3	1852	3112.2	648.8	8.3	1480	2137.1	0.69		0.52
19. Clint, TX	1676.6	1.9	0	1678.5	832.1	1.7	0	833.8	0.50	0.52	0.50
20. Magna, UT	578.6	7.2	2000	2585.8	298.0	6.3	1750	2054.3	0.79		0.51
Range	56-1717	1-28	0-2000	56-3112	31-938	1-21	0-1750	32-2061	0.50-0.79	0.35-0.60	0.50-0.59
Mean	807	11	663	1481	429	9	534	972	0.63/0.59[a]	0.46	0.55
Stand. Dev.	648	9	816	1081	334	7	697	785	0.10/0.09[a]	0.10	0.03
Non-IP Sites											
2. Hayden, AZ	1147.5	0.7	1560	2708.2	595.4	0.5	1435	2030.9	0.75		
4. S. Central Ave., Phoenix, AZ	453.7	12.2	374	839.9	258.3	12.2	210	480.5	0.57		
5. Safford, AZ	998.0	5.2	5	1008.2	484.4	3.9	2	490.3	0.49		
6. Yuma, AZ	3186.1	12.6	70	3268.7	1642.3	9.9	47	1699.2	0.52		
8. Brawley, CA	887.2	33.2	200	1120.4	462.8	25.5	130	618.3	0.55		
9. China Lake, CA	334.8	0	8	342.8	170.7	0	7	177.7	0.52		
10. El Centro, CA	738.1	32.5	569	1339.6	408.3	23.9	384	816.2	0.61		
11. Fontana, CA	302.2	3.8	3707	4013.0	156.1	3.1	3398	3557.2	0.89		
12. Oildale, CA	332.8	4.3	3911	4248.1	186.2	3.4	3529	3718.6	0.88		
15. Anthony, NM	2425.6	6.1	0	2431.7	1231.7	5.3	0	1237.0	0.51		
16. Hurley, NM	1172.6	5.0	2306	3483.6	638.8	4.2	2122	2765.0	0.79		
18. W. Paisano Dr., El Paso, TX	1413.7	1.3	1394	2809.0	744.2	1.3	1032	1777.5	0.63		
Range	302-3186	0-33	0-3911	840-3484	171-1232	0-26	0-3529	178-3719	0.51-0.89		
Mean	1116	10	1175	2301	582	8	1025	1614	0.64		
Stand. Dev.	886	11	1435	1330	451	9	1322	1211	0.15		

[a] 0.63/0.59 values for 8 monitors/values for 6 monitors with IP data

TABLE 8. COMPARISON OF FUGITIVE DUST SOURCE TYPES FOR TSP

Site Name	Railroad		Clean Paved Streets		Unpaved Rds/Alleys		Cleared Areas		Construction		Agriculture		Storage Areas		Unpaved Parking lots		Total
	tpy	%	tpy	%	tpy	%	tpy	%	tpy	%	tpy	%	tpy	%	tpy	%	
IP Sites																	
1. Carefree, AZ	0	0	13.8	24.8	40.7	73.2	0	0	0	0	0	0	0.8	1.4	0.3	0.1	55.6
3. Roosevelt St., Phoenix, AZ	0	0	754.0	43.9	27.0	1.6	68.1	4.0	861.5	50.2	0	0	2.0	0.1	4.8	0.3	1717.4
7. Bakersfield, CA	0.5	0.1	495.9	94.4	0.5	0.1	4.8	0.9	20.4	3.9	0	0	0	0	3.2	0.6	525.3
13. Rubidoux, CA	0	0	295.3	76.9	52.3	13.6	3.5	0.9	23.6	6.1	3.4	0.9	1.0	0.3	5.0	1.3	384.1
14. Bayard, NM	18.2	6.7	86.6	32.0	121.7	45.0	43.2	16.0	0	0	0	0	0	0	0.6	0.2	270.3
17. Campbell St., El Paso, TX	273.0	21.9	737.9	59.1	110.8	8.9	0	0	112.2	9.0	0	0	8.1	0.6	6.9	0.6	1248.9
19. Clint, TX	62.4	3.7	21.8	1.3	65.2	3.9	46.9	2.8	0	0	1461.1	87.1	12.6	0.8	6.6	0.4	1676.6
20. Magna, UT	0	0	184.6	31.9	48.8	8.4	24.8	4.3	76.8	13.3	242.5	41.9	0	0	1.1	0.2	578.6
Total	354.1	5.5	2589.9	40.1	467.0	7.2	191.3	3.0	1094.5	17.0	1707.0	26.4	24.5	0.4	28.5	0.4	6456.8
Non-IP Sites																	
2. Hayden, AZ	0	0	17.0	1.5	833.4	72.6	248.0	21.6	47.9	4.2	0	0	0	0	1.2	0.1	1147.5
4. S. Central Ave. Phoenix, AZ	0	0	303.6	66.9	48.1	10.6	39.3	8.7	55.8	12.3	0	0	4.7	1.0	2.2	0.5	453.7
5. Safford, AZ	0	0	90.0	9.0	22.7	2.3	16.1	1.6	0	0	864.7	86.6	0	0	4.5	0.5	998.0
6. Yuma, AZ	357.1	11.2	103.1	3.2	139.0	4.4	2096.1	65.8	0	0	478.5	15.3	4.1	0.1	8.2	0.3	3186.1
8. Brawley, CA	41.2	4.6	132.1	14.9	145.7	16.4	75.4	8.5	298.5	33.6	177.4	20.0	1.1	0.1	15.8	1.8	887.2
9. China Lake, CA	0	0	0.5	0.1	0	0	334.3	99.9	0	0	0	0	0	0	0	0	334.8
10. El Centro, CA	53.4	7.2	355.9	48.2	70.4	9.5	248.2	33.6	0	0	5.5	0.7	0	0	4.7	0.6	738.1
11. Fontana, CA	2.7	0.9	104.5	34.6	44.8	14.8	2.9	1.0	0	0	144.7	47.9	1.4	0.5	1.2	0.4	302.2
12. Oildale, CA	0	0	87.2	26.2	171.2	51.4	60.2	18.1	0	0	0	0	0	0	14.2	4.3	332.8
15. Anthony, NM	127.4	5.3	26.7	1.1	112.0	4.6	1197.7	49.4	0	0	957.6	39.5	0	0	4.2	0.2	2425.6
16. Hurley, NM	44.2	3.8	30.3	2.6	762.3	65.0	332.0	28.3	0	0	0	0	0	0	3.8	0.3	1172.6
18. W. Paisano Dr., El Paso, TX	348.4	24.6	185.5	13.1	168.7	11.9	711.1	50.3	0	0	0	0	0	0	0	0	1413.7
Total	974.4	7.3	1436.4	10.7	2518.3	18.8	5361.3	40.0	402.2	3.0	2628.4	19.7	11.3	0.1	60.0	0.4	13402.3

emissions. Area combustion sources showed little variation between the IP sites and non-IP sites ($\bar{x}$ = 11 for IP sites and 10 for non-IP sites). Point sources emissions around non-IP sites were significantly higher, averaging 77 and 92 percent more than the IP sites for TSP and PM_{10} emissions. A closer examination of the point source difference shows that among IP sites, only the El Paso (six sources <500 tons/yr = 1852 tons/yr) and Magna (Kennecott 2000 tons/yr) sites had large point source emissions. Among non-IP sites, four sites were influenced by major point sources totaling 1394 to 3911 tons per year of TSP. Because the non-IP sites had both higher average area and point source emissions, total emissions for non-IP sites averaged 55 and 66 percent higher for TSP and PM_{10} compared with the IP sites.

Overall, 50 percent of the TSP emissions and 38 percent of the PM_{10} emissions calculated for the 20 sites were attributable to fugitive dust sources. Less than 1 percent of the emissions for both TSP and PM_{10} were due to area source combustion emissions. The remainder were attributable to point sources (49 and 61 percent). For the IP sites the fugitive dust contributions of the total emissions were 54 and 44 percent for TSP and PM. Equivalent values for the non-IP sites were 48 and 36 percent. In all cases, the fraction of the PM_{10} emissions attributable to fugitive dust was lower than that for TSP. Conversely, the fraction attributable to point sources was higher for PM_{10}.

A comparison of TSP area source fugitive dust categories is shown in Table 8. The percentage of total emissions rows for each category indicates that the percentage of clean street emissions at IP sites (38.3 percent) is significantly greater than the 10.7 percent for non-IP sites, which demonstrates a generally more urban exposure for IP sites. Conversely, 40 percent of the fugitive dust source emissions from non-IP sites were from cleared areas, versus only 3.0 percent at IP sites. Non-IP sites also had a higher percentage of emissions from unpaved roads and alleys, whereas the IP sites had a higher percentage of construction emissions. In summary, emission types from IP sites are more indicative of more fully developed urbanized areas with a greater percentage of paved roads and fewer cleared areas.

Comparison of PM_{10}/TSP Emission Ratios at IP and Non-IP Sites

The PM_{10}/TSP ratios calculated for all 20 sites (Table 7) showed the values were remarkably close, with similar ratios (0.63, 0.64) and similar standard deviations (0.10, 0.15). The non-IP site ratios, however, had a higher range, as they were influenced by the point sources near the Fontana (Kaiser Steel), Oildale (Chevron Oil, Getty Oil, Shell Oil), and Hurley (Kennecott Copper Smelter) sites.

The nearly identical ratios are partly a function of the calculation methodology. For fugitive dust sources, the PM_{10} fraction used varied from only 0.50 to 0.59 of TSP emissions (excluding agricultural tilling). The point sources also had a narrow PM_{10} fraction band, generally from 0.85 to 1.00. In reality, particle size distributions may not be in two such homogenous groupings; however, relatively little data are available for calculating PM_{10} from TSP emissions.

Comparison of Emissions PM_{10}/TSP Ratio With Ambient Ratio

Converting IP monitored values to PM_{10} (see Section 2) made it possible to compare the microinventory-derived PM_{10}/TSP emissions ratio with the monitored PM_{10}/TSP ratio. This comparison was made for five sites (1, 3, 7, 13, 19). The monitored ratio of 0.46 was lower than the microinventory emissions ratio of 0.60 for the sites. There are several possible explanations for this factor. Assuming the monitored values are correct, possible theoretical explanations are:

1) The microinventories resulted in an underestimation of fugitive area source TSP emissions, which would result in an underestimate of the TSP value for the denominator. A higher value would decrease the ratio. For these five sites, the PM_{10}-to-TSP ratio for fugitive dust was 0.56.

2) The influence of PM_{10} emissions from point sources in a 5-mile radius of the site may not be as direct as assumed, as emissions from point sources generally have a higher PM_{10}/TSP ratio. For the three sites with point source emissions, the PM_{10}/TSP ratio was 0.69. This could result in an overestimation of the numerator value.

3) The conversion from TSP emissions to PM_{10} emissions for area and point sources could be inaccurate with an unknown positive or negative impact. In other words, there could be an error in the basic emission factor equations.

Assuming the microinventories are correct, possible explanations are:

1) At sites heavily impacted by fugitive dust, the high-volume sampler (hi-vol) may not have a D_{50} of 30 micrometers; it may be higher. This would have the impact of increasing the denominator and reducing the ratio.

2) The dichotomous samplers used for the IP monitoring may not have a D_{50} of 15 micrometers; it may be lower. This would decrease the numerator and thereby reduce the ratio.

To investigate the theoretical explanations, data were obtained relevant to particle collection efficiency of the hi-vol and dichotomous samplers (TSP and PM_{10} measurement devices). Two findings about the hi-vol are of interest. First, preliminary data about the collection efficiency of a hi-vol indicate that the D_{50} particle size cut of 30 micrometers decreases with increasing windspeed. The exact function will not be established until additional research with dry particles such as those found in the Southwest are completed (Rhodes 1984). Of greater significance are preliminary results from EPA's PM_{10} Monitor Intercomparison Study. In this study a wide range aerosol classifier (WRAC) was collocated with a hi-vol and PM_{10} measurement device. This device consists of a group of high-volume single-stage impactors arranged in parallel. Each sampler has a different particle size cutpoint for the impactor stage. Based on WRAC results and data from Rubidoux, California, and Phoenix, Arizona, the hivol monitors of these two locations appear to have a D_{50} of about 50 micrometers under ambient monitoring conditions (Rhodes 1984). Other sampler data on the dichotomous sampler indicate that the D_{50} of an IP dichotomous sampler also decreases with windspeed, with the 15 micrometer cut achieved at about 9 miles per hour. Average windspeed for the monitor locations used in this study was 7.2 miles per hour. At this windspeed, the dichotomous sampler D_{50} particle collection efficiency would be about 16.5 micrometers, a relatively small error considering the particle size distribution of ambient air.

Although the windspeed-induced errors in the dichotomous sampler are relatively small, the finding of the D_{50} at 50 micrometers for the hi-vol is significant. For direct comparison of the emissions ratio with the ambient ratio, it is necessary to inflate the emissions estimate by the ratio of D_{50} of 50 micrometers over the D_{50} of 30 micrometers. This ratio affects primarily the area fugitive sources. The five particle size distributions from AP-42 used with the fugitive sources were examined. The use of a lognormal interpolation between Total Particulate and 30 micrometers showed that the ratio of emissions less than 50 micrometers to emissions less than 30 micrometers was 1.12. The point source emissions could have been similarly modified to represent a D_{50} of 50 micrometers, but they were not because the PM_{10}/TSP ratios were generally in the range of 0.85 to 1.0 for individual processes. Any change due to a modification would have been slight. Modifying the area source emissions in Table 8 for the five IP sites results in a change of the emissions ratio from 0.60 to 0.54. This ratio is still greater than 0.46, the ambient ratio. This difference in the ratios must be attributable to one of the other explanations, a combination of the theoretical explanations just listed, or to an unknown variable.

Comparison of Study Ambient Ratio With National Ambient Ratio

The study ambient PM_{10}/TSP ratio is 0.46. The national ambient PM_{10}/TSP ratio from the IP network is also 0.46. Conventional wisdom would hold that the ratio in the Southwest should be lower than the national average, because the West has a lower background concentration (particles <10 micrometers), more fugitive dust (particles >10 micrometers), and fewer point sources (particles <10 micrometers) than the East. The conventional wisdom requires further consideration.

Regarding background concentrations, a comparison of eastern and western sites in the IP network (PEDCo 1984b) at background monitors indicates that the PM_{10} average concentration was 21.2 µg/m³ in the East, and 24.5 µg/m³ in the West, i.e. the conventional wisdom is contradicted by these monitoring data.

There probably are more fugitive emissions in the West than in the East; however, the emissions from these sources are not as coarse as commonly assumed. This greater amount of fugitive emissions increases both the denominator and the numerator of the ratio. Because the PM_{10} ratio for fugitives is roughly 0.5, the ratio for all emissions will stay near 0.5 when fugitive emissions are added to the ambient air. For example, if the PM_{10} ratio was near 0.5 and the TSP value was 60 µg/m³, 30 µg/m³ would be PM_{10}. Adding 10 µg/m³ of TSP emissions to the ambient air of fugitive emissions would change the TSP value to 70 µg/m³ and the PM_{10} value to 35 µg/m³, again resulting in a ratio of 0.5.

Regarding point sources, 13 of 20 monitors were impacted by point source emissions of greater than 200 tons of TSP per year. Seven of 20 monitors were impacted by point source emissions of greater than 1400 tons of TSP per year.

In conclusion, it is clear that some of the conventional wisdom is in error. First, PM_{10} background concentrations are slightly higher in the West than in the East. Because fugitive emissions have a PM_{10} ratio of about 0.5, the addition of fugitives does not change the overall PM_{10} ratio very much. Western monitors are also impacted by point sources. These three factors combined make it likely that the ambient ratio for the Southwest should be similar to the national average ratio.

SECTION 4

EVALUATION OF MEASURED AIR QUALITY AND METEOROLOGICAL VARIABLES

It has been hypothesized that high monitored particulate concentrations in the Southwest may be due, at least in part, to the hot and dry conditions in the region. This section presents an analysis of the impact of specific meteorological variables, both on an annual and a daily basis. The final subsection analyzes the relationship between windstorms and measured concentrations.

ANNUAL METEOROLOGICAL VARIABLES

The data base developed for the analysis of annual meteorological variables includes 50 TSP, 8 IP, and 50 calculated PM_{10} annual arithmetic means; number of samples for each air quality mean value; mean annual wind direction (10-degree sectors; 00-36) and windspeed; peak windspeed; and annual precipitation. These data are summarized in Table 9. Derivation of the air quality values was described in Section 2.

Most of the meteorological data were obtained from data summaries of the National Weather Service (NWS) station nearest to the site. The exception was the precipitation data. In cases where local precipitation records were available for sites closer to the monitor than the NWS station, these local data superseded the NWS data.

The data in Table 9 were input to the MLR program, and the outputs were examined for significant variables. For PM_{10} the results were as follows:

TABLE 9. MEASURED AIR QUALITY VS. ANNUAL METEOROLOGICAL VARIABLE

Site	Year	Annual arithmetic mean conc., μg/m³			No. of samples			Mean wind dir., 10° sector	Mean wind-peed, mph	Peak wind-speed, mph	Precip-itation, in.
		TSP	IP	PM_{10}	TSP	IP	PM_{10}				
1	82	46	21	16	43	49		16	5.5	60	9.94
2	82	172		81	52			18	8.4	42	19.45
2	83	119		56	51			18	8.3	46	28.05
3	82	95		45	55			16	5.5	60	9.94
3	82	101	54	42	53	43		16	5.5	60	9.94
4	82	128		60	61			16	5.5	60	9.94
5	82	122		57	59			18	8.4	42	13.35
5	83	110		52	56			18	8.3	46	28.05
6	82	101		47	59			a	a	38	5.46
6	83	119		56	53			a	a	42	5.36
9	82	26		12	52			33	6.0	25	7.79
10	82	123		58	42			a	a	38	5.46
11	80	129		61	51			26	7.7	46	53.10
11	81	143		67	56			25	7.5	48	16.01
12	82	107		50	99			33	6.0	25	7.79
12	83	108		51	49			24	6.7	32	10.86
13	82	118		55	50			26	7.9	60	38.75
13	80	161	88	67	56	35		26	7.7	46	53.10
13	82	130	92	78	45	38	36	26	7.9	60	38.75
14	82	132		62	57			25	7.0	36	13.06
14	83	116		54	60			22	7.2	37	7.99
14	81	122	89	69	55	52		24	7.3	40	16.80
14	82	110	72	56	48	37		25	7.0	36	13.06
15	82	131		61	57			25	7.0	36	11.18
15	83	116		54	60			22	7.2	37	7.99
16	82	112		52	57			25	7.0	36	13.06
16	83	98		46	59			22	7.2	37	7.99
17	82	99		47	52			25	7.0	36	10.97
17	83	96		45	51			22	7.2	37	7.99
18	82	170		80	56			25	7.0	36	10.97
18	83	139		65	57			22	7.2	37	7.99
19	81	67	46	35	50	53		24	7.3	40	12.63

(continued)

TABLE 9 (continued)

Site	Year	Annual arithmetic mean conc., µg/m³			No. of samples			Mean wind dir., 10° sector	Mean wind-speed, mph	Peak wind-speed, mph	Precip-itation, in.
		TSP	IP	PM_{10}	TSP	IP	PM_{10}				
20	83	55		26	56			17	9.4	47	24.26
20	81	69	44	34	45	24		19	9.0	43	16.59
22	82	112		53	57			33	6.0	25	7.79
22	83	108		51	42			24	6.7	32	10.86
23	82	166		78	50			a	a	38	5.46
25	82	99		47	56			25	7.0	36	10.97
25	83	89		42	61			22	7.2	37	7.99
26	82	115		54	56			25	7.0	36	10.97
26	83	112		53	62			22	7.2	37	7.99
27	82	136		64	60			25	7.0	36	10.97
27	83	192		90	47			22	7.2	37	7.99
28	82	66		31	61			25	7.0	36	10.97
28	83	60		28	55			22	7.2	37	7.99
29	82	186		87	57			25	7.0	36	10.97
29	83	121		57	59			22	7.2	37	7.99
30	82	47		22	58			17	9.6	45	22.86
30	83	55		26	237			17	9.4	47	24.86
31	83	58		27	60			17	9.4	47	24.86

a = Data not available

Step	Variable (in order of output)	R	R^2	Significance
1	Mean wind direction	0.21	0.044	0.160
2	Peak windspeed	0.23	0.054	0.510
3	Precipitation	0.24	0.056	0.805
4	Mean windspeed	0.24	0.058	0.727

Similarly, for TSP the results are:

Step	Variable (in order of output)	R	R^2	Significance
1	Mean wind direction	0.18	0.032	0.232
2	Mean windspeed	0.19	0.038	0.627
3	Precipitation	0.23	0.054	0.397
4	Peak windspeed	0.24	0.059	0.658

As is evident from the results, this analysis did not produce any meaningful insights into the relationship between annual air quality and meteorological parameters. There is some difference in the results of the two analyses because not all of the PM_{10} data were calculated from TSP data. None of the variables evaluated (singly or in combination) explain a significant portion of the variance in measured air quality at the sites.

DAILY METEOROLOGICAL VARIABLES

The previous analyses used annual average air quality data with various independent variables in an attempt to describe the variation in measurements between sites. The results were not meaningful. In this section, daily air quality and meteorological variables were examined to see whether variations in day-to-day meteorological conditions could be used to explain the variation in measured concentrations.

The 20 sites that were microinventoried were divided into two subsets. The first subset contained data for the eight IP network sites. The second subset consisted of the remaining 12 sites. The air quality data used for the first subset consisted of paired TSP and IP readings over the period May 1979 to

December 1982. For each day that paired data were available, a number of meteorological parameters were extracted from NWS Local Climatological Data Summaries of the nearest reporting station. It should be noted that the large distance between a monitor site and the nearest meteorological site may, in some instances, result in meteorological data that are not representative of the conditions at the monitor. The data extracted from the summaries included:

1. Resultant wind direction
2. Resultant windspeed
3. Average windspeed
4. Peak windspeed
5. Precipitation
6. Number of days since rain exceeding 0.01 in.
7. Number of days since rain exceeding 0.10 in.
8. Number of days since rain exceeding 0.25 in.

For the last three data items, the maximum number of days since rain was set at 7, as it was assumed that any effects of precipitation would be negligible after 7 days. One final variable compiled for each site was whether the sample was collected on a weekday or a weekend. For each IP measurement, an equivalent PM_{10} measurement was calculated in the MLR program by multiplying the IP readings by 0.77 (Subsection 2.4). A similar data compilation was prepared for the other 12 sites; however, in this summary, only TSP data were used.

The concept behind this division of data sets was twofold. With the first subset, it would be possible to evaluate the relationship between air quality measurements and meteorological variables for both TSP and PM_{10}. In addition, the ratio of PM_{10}/TSP could be evaluated with the same variables. If a consistent relationship could be established for the first subset of TSP and PM_{10} data, it might be possible to expand the relationship to the sites where only TSP data were available.

Multiple Regression Analyses

Individual Site Regressions for IP Sites--

The data for each IP site were first input to the MLR program. For each site, a regression was performed and then the results were examined. The next step was to perform the evaluations for the entire data set. The third step involved an evaluation of the PM_{10}/TSP ratio for six subgroups. These subgroups were based on three levels of either mean windspeed or peak windspeed.

The results of the regressions performed with data from the IP network sites are shown in Table 10 as linear equations. Both TSP and PM_{10} results are included in the table. The data base used included only days when both TSP and IP measurements were available. The IP concentrations were converted to PM_{10} concentrations by multiplying them by the 0.77 factor discussed in Subsection 2.4.

For this analysis the following abbreviated variable descriptors were used:

1. RESDIR - resultant wind direction, 10° sectors
2. RESWS - resultant windspeed, mi/h
3. AVGWS - average windspeed, mi/h
4. PEAKWS - peak windspeed, mi/h
5. PRECIP - precipitation amount, in.
6. DSR01 - number of days since rain, 0.01 or more in.
7. DSR10 - number of days since rain, 0.10 or more in.
8. DSR25 - number of days since rain, 0.25 or more in.
9. WDWE - weekday/weekend; weekday = 1, weekend = 0

These abbreviations are used in Table 10 and in the following discussions. The data in Table 10 do not include all of the program results. Only those variables that are significant at the 0.05 level or better are included. The remaining variables will not significantly improve the correlations. In addition, the R values have been eliminated from these summaries; however, they can easily be calculated given the R^2 value.

TABLE 10. REGRESSION RESULTS FOR IP NETWORK SITES
(all variables significant to .05)

Site	Particle Size	N	R^2	Equation
1	TSP	61	0.56	4.6(DSR01) + 0.5(RESDIR) + 3.0(AVGWS) - 36.5(PRECIP) - 2.3
	PM_{10}	61	0.46	2.1(DSR01) + 0.2(RESDIR) + 1.6(AVGWS) - 15.7(PRECIP) - 15.7
3	TSP	78	0.40	10.1(DSR01) - 2.4(PEAKWS) + 100.4
	PM_{10}	78	0.38	6.1(DSR01) - 6.3(AVGWS) + 4.0(RESWS) + 39.4
7	TSP	38	0.42	12.2(DSR01) - 11.2(AVGWS) + 116.3
	PM_{10}	38	0.55	6.5(DSR01) - 9.2(AVGWS) + 70.8
13	TSP	78	0.42	16.1(DSR01) - 3.1(PEAKWS) + 108.8
	PM_{10}	78	0.43	8.8(DSR01) - 11.8(AVGWS) + 6.0(RESWS) + 1.4(RESDIR) + 54.9
14	TSP	83	0.30	6.8(DSR01) - 543(PRECIP) + 26.7(WDWE) + 70.1
	PM_{10}	83	0.18	3.6(DSR01) - 6.9(DSR25) - 207(PRECIP) + 86.2
17	TSP	51	0.20	10.0(DSR01) + 71.7
	PM_{10}	51	0.28	5.9(DSR01) - 2.5(RESWS) + 36.0
19	TSP	120	0.25	9.2(DSR01) + 1.2(RESDIR) + 10.7
	PM_{10}	120	0.24	4.4(DSR01) + 0.6(RESDIR) + 5.0
20	TSP	41	0.36	6.0(DSR01) - 1.2(RESDIR) + 61.0
	PM_{10}	41	0.45	3.0(DSR01) - 0.8(RESDIR) - 1.2(RESWS) + 36.3
All IP Sites	TSP	550	0.19	9.6(DSR01) + 0.8(RESDIR) - 1.3(PEAKWS) + 1.6(RESWS) + 49.9
	PM_{10}	550	0.15	4.5(DSR01) + 0.3(RESDIR) - 21.6(PRECIP) + 18.9

As shown in Table 10, only two of the equations have significant variables that explain over 50 percent of the variance in the data (Site 1-TSP, Site 7-PM_{10}). It is interesting to note that all of the sites have DSR01 as a significant variable with a positive coefficient. This result suggests the fugitive nature of the sources impacting the monitors. Rainfall generally suppresses fugitive dust emissions on the day of precipitation, and the emissions then increase for a few days until the material is once again dry. The TSP coefficients range from 4.6 to 16.1, and the PM_{10} coefficients range from 2.1 to 8.8. Sites 1 and 14 also exhibited a decrease in concentration on days of precipitation. Site 1 (Carefree) is located near a dirt taxiway at a rural airport. Site 7 (Bayard) is located in an unpaved school bus parking lot. Both locations would have lower localized emissions on the days with precipitation. RESDIR was a significant variable at four sites. At three of the sites the coefficient is positive, and at the fourth it is negative. This suggests that the highest concentrations at the first three sites are associated with a particular wind direction and that the lowest concentrations at the fourth site are associated with a particular direction. If pollution roses were developed for these sites, they might indicate the direction of the significant emission points.

A similar dichotomy exists for the several measurements of windspeed. In some cases the coefficients are positive, in others they are negative. A problem arises when attempting to correlate windspeed to TSP because windspeed has a positive and negative effect on TSP. As windspeed increases, suspension of particles increases, which tends to increase concentrations. Greater dispersion of particulate matter also occurs with increasing windspeed, which decreases concentrations. Under high wind conditions the increased suspension of particles is often overshadowed by the effects of dispersion, but when 24-hour mean windspeed is addressed, the two consequences of windspeed cannot be separated.

The relationship between concentrations and the various meteorological variables is not straightforward. It is interesting to note that from 18 to 56 percent of the variance in the air quality data can be explained by just the meteorological variables at any one site. The relationships shown in Table 10 do not include the other interrelationships that exist near a monitor: source-receptor geometry, and meteorological variables versus source and receptor locations.

One final analysis was performed with these data. The daily PM_{10}/TSP ratio was calculated for each data point and regressed against the meteorological variables, both as a whole and with specific attention to three ranges of peak windspeed and average windspeed. No significant variables were identified during the regression analysis.

Non-IP Sites--

For the 12 sites that were not a part of the IP Network, only TSP air quality data were available. For these sites, the MLR program was exercised with the daily TSP values and their associated meteorological parameters. No PM_{10} conversions were performed because no reasonable method of converting over 1200 daily TSP values to equivalent PM_{10} values could be devised other than by multiplying each by an identical constant.

The results of these analyses are shown in Table 11. These results explain less than 40 percent of the variance in the measured data at each site. Similar to the results for the IP sites, DSR01 is a significant variable at 11 of the 12 sites. At site 8 (Brawley) the lack of significant relationships may be a function of the limited data base for that site. At site 6 (Yuma) the coefficient (-298) for PRECIP suggests the extreme reduction in fugitive dust emissions realized by rainfall in this arid location. Five of the sites (5, 6, 9, 15, 18) show a positive coefficient for PEAKWS, which suggests a possible impact of duststorms or wind-erosion emissions under high wind conditions; however, the simple correlations between peak windspeed and

TABLE 11. REGRESSION RESULTS FOR NON-IP NETWORK SITES
(all variables significant to .05)

Site	N	R^2	Equation
2	105	0.09	10.6(DSR01) + 99.8
4	101	0.22	7.9(DSR01) - 3.4(RESWS) + 94.7
5	115	0.28	10.7(DSR01) + 2.0(PEAKWS) + 33.8
6	112	0.33	6.4(DSR01) + 5.0(PEAKWS) - 298(PRECIP) - 4.8
8	33		no significant variables
9	83	0.36	3.2(DSR01) + 1.2(PEAKWS) - 4.0
10	61	0.10	15.4(DSR25) + 9.2
11	104	0.30	19.8(DSR01) + 19.9
12	148	0.36	11.2(DSR01) + 63.0
15	117	0.37	14.3(DSR01) + 41.2(WDWE) + 3.3(PEAKWS) - 17.5
16	115	0.29	8.5(DSR01) - 2.2(RESDIR) + 30.1(WDWE) + 85.2
18	113	0.21	10.2(DSR01) - 4.0(RESDIR) + 3.0(PEAKWS) + 135.9
All	1207	0.12	9.0(DSR01) + 0.8(PEAKWS) - 0.5(RESDIR) + 8.2(WDWE) + 58.0

concentration are rather low. As discussed earlier, windspeed may have both a positive and negative effect on measured concentrations. Further, the results support this concept because no definitive relationship was established.

Further analyses of this particular observation were performed by grouping the entire data base (20 sites) into three subgroups of average windspeed and three subgroups of peak windspeed. None of the regression analyses explained over 7 percent of the variance in the data.

None of the regression analyses in this section revealed any definitive relationships between measured concentrations and daily meteorological variables. Previous studies performed by PEI for TSP nonattainment sites impacted by fugitive dust sources have shown equally variable results (PEDCo 1978, 1983). By their nature, the ubiquitous fugitive dust sources are intermittent sources of particulate and are not easily explained by regression analyses.

RELATIONSHIP BETWEEN DUSTSTORMS AND MONITORED TSP CONCENTRATIONS

Those familiar with the southwest know that the periodic duststorms that occur in this region can reduce visibility to almost zero. During these storms, which last from minutes to hours, particulate concentrations are extremely high as a result of natural as opposed to man-made phenomena.

Duststorm Events

As a means of examining the frequency of duststorms near the eight IP microinventoried monitors, data from the nearest NWS station (sometimes as much as 100 miles away) were examined for the parameter, "Weather Condition--Duststorm." This parameter is defined as a condition of less than 5/8 mile visibility for any duration of time. This level of dust in the air would be indicative of concentrations in the several hundreds of $\mu g/m^3$. A total of 40 windstorm events were recorded at the NWS stations closest to the eight IP monitors over the approximately 3-year period. This factor in itself suggests that the definition used by the NWS to qualify for a windstorm event is quite restrictive. Of the 40 windstorm events, only 5 days corresponded with days having measured air quality at four sites. This limited data set, which is shown in Table 9, is inconclusive because of the small number of cases and the discrepancy of results. In two cases, the monitored value on the duststorm day was less than the annual mean. On 3 days, the reverse was true.

The NWS data were only of limited utility for this exercise. Because of the criteria used by the NWS to define a duststorm event, few days with duststorms are reported. No indication is given in the NWS summaries as to the duration and location of the event. For the four monitoring sites shown in Table 12, it is impossible to determine whether the event was also occurring at the monitor site. In the case of the Bayard site, it is unlikely that conditions observed at the NWS site were also prevalent at the monitor 132 miles away. For the other sites, the distance of 3 to 16 miles separating the monitors and the NWS locations could also be a significant factor. Further, NWS data cannot be used to define more localized phenomena such as the familiar "dust-devils."

High-Volume Sampler Cut-Point

As noted in Subsection 3.4, the collection efficiency of a hi-vol changes from a D_{50} of 30 micrometers to a D_{50} of a smaller particle size under high wind conditions. The change in particle size collection efficiency with windspeed has not been fully characterized; however, this change would have the effect of measuring a lower concentration than was actually present in the ambient air. Although the magnitude of the duststorm phenomenon, and the partially off-setting change in particle size collection are not known, it is believed that the dust storm phenomenon would predominate.

TABLE 12. RELATIONSHIP BETWEEN WINDSTORMS AND MONITORED TSP CONDITIONS

Site Name	Date of duststorm vents	Proximity of NWS to TSP monitoring	24-hour TSP concentration, μg/m³	Mean annual TSP concentration, μg/m³
3. Roosevelt St., Phoenix, AZ	8-16-83	3 miles SW	64	106
	7-22-82		218	95
14. Bayard, NM	7-4-82	121 miles SE	106	132
17. Campbell St., El Paso, TX	7-4-82	6 miles NE	131	99
19. Clint, TX	7-4-82	16 miles NW	208	89

Theoretical Approach

Duststorms can be a single hour to multiple hours to days in duration. Assuming that an average hourly concentration prior to a windstorm was 60 μg/m³ and that the concentration during a windstorm hour was 500 μg/m³, a windstorm of one hour's duration would increase the 24-hour value from 60 μg/m³ to 78 μg/m³. If the storm were 2 hours in duration, the value would be 97 μg/m³; 3 hours in duration, 115 μg/m³; etc. If the TSP 24-hour standard value of 260 μg/m³ is considered, the above assumptions would show that a duststorm of 11 hours' duration would produce a 24-hour concentration in excess of 260 μg/m³.

This theoretical approach would tend to indicate that duststorms would need to be quite lengthy to cause a violation of the 24-hour standard.

SECTION 5

POTENTIAL REGULATORY APPROACHES

Three potential regulatory approaches to remedy a nonattainment situation should be considered. Whereas each would have some impact if adopted in isolation, maximum potential benefit would be achieved with all three programs in place.

SITING CRITERIA

Existing TSP monitor siting criteria (Federal Regulations 121:2234) state the following:

2.3 Spacing from roads

> "...Except for situations where the monitoring objective is to determine the impact of a single source, ambient monitors should not be located so as to measure the plume of a single source ... For TSP, it is appropriate that ambient monitors be located beyond the concentrated particulate plume generated from traffic, and not so close that the roadway totally dominates the measured ambient concentration...

2.4 Other Considerations

> "Stations should not be located in an unpaved area unless there is vegetative ground cover year round so that the impact of reentrained or fugitive dusts will be kept to a minimum."

As shown in previously cited Table 7, 11 of the 20 microinventory sites (2 IP sites, 9 non-IP sites) had siting issues because they were located very near either unpaved roads (a possible violation of Section 2.3 of the siting criteria) or exposed areas with little or no vegetative cover (a possible violation of Section 2.4 of the siting criteria). Several of the drive-by sites were also very close to unpaved roads and exposed areas. Siting of these monitors in other locations would significantly improve measured air quality.

Even in areas where fugitive dust sources are pervasive, the issue of the proximity of a monitor to a specific source is subject to interpretation. In this report, a number of monitor locations were identified where it is believed that the monitor could have been sited differently to provide results more representative of a given area.

This concept of source proximity is still a subject of debate. The proposed revisions to the NAAQS for PM_{10} will include further guidance for monitor siting in the vicinity of specific sources. At this time, it is premature to speculate on the exact form of the final recommendations; however, as evidenced by the discussion in this report, monitor siting is one of the critical aspects that need to be addressed for PM_{10} monitoring.

MODIFICATION OF MEASURED VALUES

The periodic duststorms that occur in the Southwest can reduce visibility to almost zero. During these storms, which range in duration from minutes to hours, particulate concentrations are extremely high as a result of natural as opposed to man-made phenomena. Because local agencies cannot be expected to control duststorms, the concept of removing monitored values influenced by duststorms was explored.

Representatives of Texas, New Mexico, California, and Arizona air agencies were contacted (Butts 1984, Shankar 1984, Cook 1984, Guyton 1984). None of the States currently remove any data from their data base (although some local agencies may), even if they know it was influenced by a duststorm. Only Texas has a system whereby they flag "duststorm" influenced data. Although most were favorable to the idea, the Arizona representative noted that many monitors are in remote locations and no hard data on windstorm occurrences are available.

Unfortunately, the data on windstorms and measured concentrations presented in Section 4.0 were inconclusive because of the small data base. In addition, the distance between the NWS station and the monitor may confound the results. Further, the phenomenon may be confounded by the changing collection efficiency of a hi-vol in high winds. In spite of these facts, it is still believed that windstorms are responsible for some periods of high measured values and might strongly influence attainment of 24-hour standards.

REGULATION OF FUGITIVE DUST SOURCES

The influence of fugitive dust sources near monitors has been noted throughout the report. Also, as noted in Section 2, the microinventory results indicated the presence of a large number of exposed areas, unpaved roads, unpaved alleys, and unpaved parking lots. Fugitive dust sources are directly regulated by local and state governments as opposed to indirect regulation by the Federal government through SIP action. Many of the locations visited had vast areas of cleared exposed areas (as opposed to sparse natural vegetation) that have never been treated with a dust suppressant or revegetated, and also miles and acres of unpaved roads, alleys, and parking lots that had never been treated. Even though fugitive dust control is indeed more difficult in the semi-arid and arid Southwest, application of some dust-control methods is clearly possible.

Many locations have instituted all or some of the following controls (EPA 1978; EPA 1979b; EPA 1979c; EPA 1979d; EPA 1979e; Ohio EPA 1980):

(1) Paving of unpaved roads or stabilization with a chemical dust suppressant.

(2) Paving of unpaved parking lots or stabilization with a chemical dust suppressant.

(3) Revegetation or chemical stabilization of exposed areas.

(4) Removal of spills from streets.

(5) Control of trackout from construction sites.

(6) Covering of truck loads.

(7) Promoting agricultural practices that minimize dust generation.

Particularly at the Arizona, Texas, and New Mexico sites, the existence of such dust control measures was not evident. Not all of the control measures outlined above may be appropriate in all areas; however, fugitive-dust-control plans should include consideration of these possibilities.

FURTHER REGULATION OF POINT SOURCES

The sites impacted by major point sources were Hayden, Fontana, Oildale, Hurley, and Magna. Point source emissions of TSP at individual facilities ranged from 846 to 2940 tons per year. Control systems at individual plants were not reviewed as part of this study; however, visible observations made during the microinventories suggest that the potential exists for improvement of air quality from additional point source controls at 5 of 20 sites studied.

SECTION 6

SUMMARY AND CONCLUSIONS

The purpose of this project was to answer the following questions:

(1) What are the sources that are expected to contribute to high PM_{10} concentrations in the southwest?

(2) To what extent does meteorology play a role in high Total Suspended Particulate (TSP) concentration (e.g., high windspeed and lack of rainfall).

(3) What are potential remedies to a nonattainment situation at these sites?

Subsections 6.1 through 6.3 summarize the findings of previous report sections in meeting the three study objectives.

SOURCES THAT ARE EXPECTED TO CONTRIBUTE TO HIGH PM_{10} CONCENTRATIONS IN THE SOUTHWEST

A total of 20 monitoring sites were microinventoried (Appendix C). When the Empirical Model described in Appendix E was used with data from 15 of these sites, less than 35 percent of the variance in the TSP and PM_{10} concentration data was explained by the model. In contrast, the model as originally developed explained 77 percent of the variance in the measured data. The model was developed with microinventory and air quality data from primarily urban monitoring sites in Kansas City, St. Louis, Birmingham, and Portland. The fact that the model explained such a small amount of the variance for the Southwest sites investigated in this study indicates that TSP air quality in the Southwest is influenced by different factors than elsewhere.

Using the same procedures as were used to develop the original Empirical Model and the Southwest microinventory/air quality data base, new regression equations were developed for TSP and PM_{10} in the Southwest. A comparison of the results (Table 13) with those from the original model development showed that the LOCAL and VISDT terms for the new equations had much higher coefficients. These two variables combined explained 42 percent of the variance in the TSP data and 40 percent of the variance in the PM_{10} data for the 15 sites evaluated (Subsection 3.2.3). At the 20 sites microinventoried, 14 monitors were within 200 feet of a roadway (the LOCAL term), and 7 of these roadways had visible plumes from passing traffic (the VISDT term). The AREA term in the new equations explained 10 and 8 percent of the variance in the TSP and PM_{10} data, and the POINT term explained 3 and 2 percent of the variance.

In contrast, in the original equation, the AREA term explained 38 percent of the variance; POINT, 20 percent; LOCAL, 4 percent; and VISDT, 5 percent. Overall, the original model explained 77 percent of the variance in the data; whereas the new forms explained 55 and 50 percent of the variance for TSP and PM_{10}.

These results from the two analyses (original model and the forms of the model developed for the Southwest) indicate the greater importance of nearby streets (paved or unpaved) on measured air quality in the Southwest compared with the areas for which the model was originally developed. (LOCAL and VISDT entered the MLR equations before the AREA and POINT terms.)

Beyond the 200-foot boundary for the LOCAL term, specific source categories impacting the study monitors were identified from the microinventory data. At the 20 monitoring sites evaluated, 50 percent of the total calculated TSP emissions were attributed to fugitive dust sources. These emissions were from sources within 1 mile of the monitor compared with the point source emissions, which were compiled out to 5 miles. Of the

TABLE 13. COMPARISON OF COEFFICIENTS FROM ORIGINAL EMPIRICAL MODEL AND SW EMPIRICAL MODEL

Term	Percent explained by	
	Original Model[a]	SW TSP Model[b]
AREA	38	10
POINT	20	3
LOCAL	4	19
VISDT	5	23

[a] Developed from data derived from Kansas City, St. Louis, Birmingham, and Portland

[b] Developed from data derived from cities in California, Arizona, New Mexico, and Texas

fugitive dust sources, 20 percent of the emissions were from clean streets, 15 percent were from unpaved roads/alleys, 28 percent were from cleared areas, 8 percent were from construction, and 22 percent were from agriculture.

The point source inventories included many types of processes. The monitoring sites that were impacted by point sources with large emission estimates included Magna, Hayden, and Hurley--smelters; Fontana--steel mill; Oildale--crude oil burning to generate steam for injection wells.

A comparison was also made between IP sites and non-IP sites to determine if both groups of sites were influenced by the same types of sources. If the same source types were present, the sites should have similar PM_{10}/TSP ratios. Given similar ratios at the two groups of sites, the use of the Probability Guidelines at non-IP network sites would be reinforced.

As shown in Table 13, it was found that point source emissions represented 45 percent of the total TSP emissions at IP sites compared with 51 percent at the non-IP sites. Within the fugitive dust categories, predominate sources between IP and non-IP sites differed considerably (Table 14). For IP sites, cleared paved streets accounted for 22.1 percent of total emissions; whereas for non-IP sites, the value was 5.2 percent. For IP sites, cleared areas accounted for 1.7 percent of emissions; or non-IP sites, the corresponding value was 19.6 percent. Other lesser differences are evident. In spite of the source differences between the two groups of sites, the calculated PM_{10}/TSP emission ratios for the sources in the inventories were almost identical (0.63 vs. 0.64). This phenomenon, however, is partially due to the relatively homogenous PM_{10}/TSP ratios assumed for the different fugitive dust source types (0.50 to 0.59). For a five-site subset of the IP network group, a troubling aspect of the results was the difference between the PM_{10}/TSP emission ratio (0.60) and the ratio of ambient concentrations for PM_{10} and TSP (0.46). This difference can be partially explained by the variation in particle size collection efficiency of the hi-vol

TABLE 14. COMPARISON OF SOURCE CATEGORIES FROM IP AND NON-IP SITES

Category	Percent of total emissions	
	IP sites	Non-IP sites
Point	44.8	51.1
Fugitive Dust		
Railroads	3.0	3.6
Clean Paved Streets	22.1	5.2
Unpaved Roads/Alleys	4.0	9.2
Cleared Areas	1.7	19.2
Construction	9.4	1.5
Agriculture	14.6	9.6
Storage Areas	0.2	0.0
Unpaved Parking Lots	0.2	0.2

with windspeed (see Subsection 3.4.3). This does not totally explain the observed difference, however.

THE EXTENT TO WHICH METEOROLOGY PLAYS A ROLE IN HIGH TSP CONCENTRATIONS

Annual meteorological variables were regressed against annual air quality data. The results were not statistically significant.

Subsequently, daily meteorological variables were regressed against daily air quality. The 20 sites that were microinventoried were divided into subsets--IP sites and non-IP sites. The meteorological variables used were wind direction; resultant, average, and peak windspeed; days with precipitation; and three indicators of days since precipitation.

Meteorological variables explained 18 to 56 percent of the variance at individual IP sites. The most significant variable in each site equation was days since rain (DSR01). Daily measurements of particulate matter exhibited a positive correlation with the variable.

A dichotomy exists for the several measurements of windspeed. In some cases, a direct relationship was found between daily air quality measurements and windspeed; in other cases, an inverse relationship was found. The difficulty in attempting to correlate windspeed to measurements of TSP relates to the dual role played by windspeed. As windspeed increases, suspension of particles from unpaved surfaces increases, which tends to increase measured concentrations; however, increasing windspeed also tends to dilute the emissions from a point source or fugitive dust source as a result of the greater volume of air passing the source, which tends to decrease ambient concentrations. Under high wind conditions the increased suspension of particles is often overshadowed by the effects of dispersion. When average windspeeds and average concentrations are evaluated, the two aspects of windspeed cannot be separated. This situation is further compounded in the case of 24-hour hi-vol measurements.

Because the D_{50} of a hi-vol changes as a function of windspeed, the TSP measurements reflect different composite size distributions depending on the windspeed. Consequently, it is difficult to make a direct comparison of concentration measurements taken during different windspeed conditions.

It would be desirable to perform a regression analysis to determine the combined effect of particulate emissions and daily meteorological variables on 24-hour TSP measurements. This analysis was not feasible, however, because the emission inventories reflect annual conditions and cannot be reliably converted to a 24-hour basis.

An analysis was performed to determine if windstorms resulted in increase measured concentrations. Although the results were inconclusive, it is believed that such a relationship does exist.

In summary, a definitive link between meteorological variables and measured concentrations was not found. The study was hampered by the fact that meteorological and air quality measurements were not made at the same location; however, this situation seldom occurs except in special detailed monitoring studies. Additional analysis of data collected with collocated meteorological and air quality measurement devices from such a special study might yield more significant results.

POTENTIAL REMEDIES TO A NONATTAINMENT SITUATION AT THESE SITES

Four potential remedies were sited in Section 5. Each would individually reduce monitored particulate levels The application of all four measures would be additive. Suggested control remedies are:

1. Evaluation of adherence to monitor siting criteria--Monitor siting regulations require that monitors not be placed so as to be overly influenced by a single source, and not be placed in exposed or unpaved parking/driving areas. Eleven of 20 monitors may be in violation of siting criteria. Nine of the 11 monitors were non-IP sites.

2. Development of procedures to flag monitored values influenced by windstorms--Although the limited data collected as part of this study do not conclusively show the impact of duststorms on measured values, intuitively, duststorms are believed to have an effect.

3. Control of fugitive dust sources--At all microinventory sites except those east of Los Angeles and Bakersfield, many common dust-control techniques were not being practiced. Such common measures include use of chemical dust suppressants or paving highly traveled unpaved roads and parking lots, stabilization or revegetation of cleared areas (as opposed to sparse vegetation), cleanup of spills, and trackout control near construction sites. Whereas it is acknowledged that fugitive dust may be more difficult to control in the Southwest, at some locations, little effort in this area was observed.

4. Control of point sources--Five of 20 sites were influenced by major point sources with emissions ranging from 850 to 3000 tons per year of TSP. Control systems on individual plants were not reviewed; however, the general level of visible emissions suggests the potential for increased control.

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APPENDIX A

MICROINVENTORY PROCEDURES

The microinventory technique described herein was developed over the past five years as part of the particulate analyses in several regional areas. The procedures followed are not necessarily technically superior to alternative methods that might be used. They have evolved as a result of this past experience, however, and are recommended for succeeding inventories, primarily to maintain consistency in data collection and to minimize the time required in the field.

The survey procedure employed was to ground-survey, via automobile, the sampler stations and all probable sources of particulate emissions within a 1-mile radius of each sampling site. This method enabled the survey team to make the best observation of overall site exposure and to identify the sources with primary impact on the samplers. The 1-mile radius around each sampler was specified because that is approximately the range to which theoretical treatments (dispersion modeling) show that low-level sources will have a significant impact.

Sources of fugitive dust and conventional point and area sources were located on maps during the ground survey and labeled with pertinent data such as size and boundaries, observed activity and operational characteristics, and estimated emission rates. Two observers independently estimated and agreed upon parameters observed at each site to increase accuracy and completeness.

PREPARATORY WORK

Point source and air quality data were obtained from the state air pollution control agency and U.S. EPA. Traffic volume maps were obtained from the State and local traffic departments. Two other types of maps were also utilized during the microinventories. USGS 7-1/2 minute quadrangle maps were used to locate sampler sites and point sources by UTM coordinates. They were also a convenient size and scale (1 in. = 2000 ft) for covering the impact area--1-mile radius for area sources and a 5-mile radius for point sources. A city street map was used for planning the survey route, navigating the survey route, and locating sources in the field.

FIELD WORK

The actual inventory procedure followed was to begin at the sampler site and survey the 1/4-mile radius area first. Photographs were taken of the sampler location. Monitor height and placement were recorded on an auxiliary data sheet. Any physical interference that could bias the air quality readings was also noted. The site code (if available), street address, and distances of the nearest intersecting streets or localized sources were determined and recorded.

The field team then observed each street within the 1/4-mile radius and noted the location of all pertinent sources on the map. Closer inspections of the sources were made as necessary. All important parameters were independently estimated and then agreed upon by the two observers. For area sources, the type, dimensions, and activity rate were recorded. For point sources, the company name and source types were noted. This information was usually recorded on an auxiliary data sheet.

The general condition of paved streets within the area was described on the 1/4-mile sketch by indicating whether streets were curbed or uncurbed. Surface conditions and dirt loadings were described as clean or dirty.

The above steps were repeated with little modification for the rest of the 1-mile radius survey area. In many cases, it was possible to inventory this area by driving across alternate streets, in a crosshatch pattern, covering each zone completely.

In this way, all intersections and sources were observed from a maximum one-block distance. All sources noted were directly examined. Locations of point and area sources were noted on the USGS map; descriptions of the sources were recorded on the data sheets.

Station Type

The purpose of this category is to describe the area surrounding the sampler. This is accomplished by use of the following descriptors:

1. Type of area - urban, suburban, center-city, rural.
2. Land use - commercial, residential, etc.
3. Topography - elevated receptor or no special terrain.

Measuring Distances of Sources

For purposes of determining the distance from a source to the sampler, the following rules were observed:

Within 200 ft of the monitor	- determine distance to within 5 percent during visit to the site
From 200 ft to 1/4 mile	- scale off the aerial photo map
From 1/4 to 1 mile	- scale off either the aerial photo map or the USGS map

Distances to sources within 200 ft of the monitor were recorded during the survey. Distances beyond 200 ft were scaled from a map and recorded on the data sheet at a later date, after completion of the field work.

Defining Sources

So that all inventories were done with the same degree of detail, it was necessary to establish exactly what sources were to be included. If a stack emission appeared to involve an industrial process not included in the point source listing, the source was noted if the facility appeared to be operating at the time of the survey.

Defining what constitutes a fugitive dust source was somewhat more difficult; however, sources of fugitive dust would include at least the following activities:

Excavating
Grading
Detonation of explosives
Earth moving
Construction
Demolition
Site preparation
Sand blasting
Mining
Quarrying
Processing of sand, gravel, and rock
Crushing
Screening
Drying
Athletic fields
Handling and transporting of materials
Barren storage areas or storage piles
Vehicle movement (reentrainment)
Unpaved roads and alleys
Unpaved parking lots
Agricultural tilling
Wind erosion of exposed surfaces
Feedlots
Campgrounds
Fairgrounds
Playgrounds

Unpaved driveways or unpaved road shoulders were not included unless they were common to all the blocks in a particular segment. The presence of these sources often resulted in increased street dirt loadings, however, and those streets were noted to be dirty.

A significant factor in determining which temporary sources to consider is the time period for which the source is expected to be active. For example, a construction site should be included as a fugitive dust source only if the air quality data are for the period of time the site is active.

A checklist for the procedures discussed above is presented in Table A-1. This list should facilitate both the planning and the execution of the field surveys so that consistent data collection is achieved for succeeding microinventories.

TABLE A-1. CHECKLIST OF STEPS IN MICROINVENTORY

Preparatory work

1. Identify sampling sites to be inventoried: record SAROAD code and street address
2. Obtain U.S. Geological Survey maps of the area (from either USGS or a local engineering supply store) or other suitable map
3. Obtain traffic data (from local COG, or city or state transportation agency)
4. Obtain recent air quality data (local or state air pollution control agency)
5. Obtain gridded inventory of area source emissions (local agency) if available
6. Obtain point source inventory including annual particulate emissions and UTM coordinates (local agency)
7. Obtain aerial photographs (from local COG, city engineering department, or federal agency)
8. Prepare maps for field survey

Field work

1. Determine distances to localized sources within 200 feet and sampler height
2. Note possible interferences or biases
3. Take photographs of site and surrounding area
4. Describe land use and topography around sampler
5. Survey 1/4-mile area: locate all sources on 1/4-mile sketch, describe on data sheet
6. Note condition of streets
7. Survey remainder of one-mile radius areas: locate sources on map, describe on same data sheet as above

Calculations

1. Allocate area source emissions (from agency inventory) to one-mile radius area and to subareas
2. Calculate emissions for discrete fugitive dust sources; assign to appropriate sectors
3. Calculate vehicle-related emissions by sector
4. Prepare table of point sources in order of increasing distance from site
5. Compare listing with point sources identified in field; add to list any source missed

APPENDIX B

DEVELOPMENT OF EMISSION FACTORS

Reentrained Dust from Paved Streets

The equation used to calculate emissions from paved road is (EPA 1983):

$$E = K(090)I \left(\frac{4}{m}\right)\left(\frac{S}{10}\right)\left(\frac{L}{1000}\right) \left(\frac{W}{3}\right)^{0.7} \qquad \text{(Eq. 1)}$$

where E = emission factor, lb/VMT
K = particle size multiplier, TSP = 0.86, PM_{10} = 0.51
I = industrial augmentation factor, $I = 1$
m = number of traffic lanes, $m = 4$
S = surface material silt content, $S = 10\%$
L = surface dust loading, $L = 160$ lb/mile
W = average vehicle weight, $W = 3$ tons

Using the above equation and the independent variable values indicated, the calculated emission factors were 0.012 lb/VMT for TSP and 0.0073 for PM_{10}. The testing on which the above equation was based did not differentiate between reentrained dust and the exhaust tire-wear emission component. Consequently, the calculated emissions from paved streets are assumed to include these components.

The emission factors for this source category reflect average dry day conditions. During periods of rainfall or snow cover, reentrainment of dust should be negligible. After the rain or snow has ended, however, the emission may be temporarily increased as a result of trackout of material from unpaved areas adjacent to the streets or from the application of sand or salt for snow control. As this deposited material dries, it may become entrained by passing vehicles. Therefore, the 0.012

lb/VMT and 0.0073 lb/VMT values represent reasonably good averages.

UNPAVED ROADS AND PARKING LOTS

Many different groups have investigated emissions from unpaved roads. All the studies show emission rates usually in the range of 1 to 20 lb/VMT, and show that the rate is highly dependent on vehicle speed. After reviewing these studies, EPA selected the following emission factor for publication in AP-42. This factor is appropriate for vehicle speeds between 13 and 40 mph (EPA 1983).

$$E = K\ (5.9)\left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-P}{365}\right) \qquad \text{(Eq. 2)}$$

where E = emission factor, lb/VMT
K = particle size multiplier, TSP = 0.80, PM_{10} = 0.45
s = silt content of road surface material, s = 12%
S = mean vehicle speed, roads = 25 mi/h, parking lots = 10 mi/h, industrial roads - 35 mi/h
W = mean vehicle weight, road and parking lots = 3 tons, industrial = 35 tons
w = mean number of wheels, residential = 4, industrial = 6
P = mean number of days with at least 0.01 inch of precipitation per year

The percent silt on gravel road surfaces is about 12 percent based on data presented in the EPA publication, Development of Emission Factors for Fugitive Dust Sources (EPA 1974). No aggregate material is applied to the road bed of graded and drained road surfaces. It is composed of compacted native soil. The fine material originally on the surface is probably rapidly removed by turbulence from passing vehicles or by wind and water erosion forces. The remaining stable surface is composed of sand- and pebble-sized particles; dust is generated primarily by the continuing mechanical breakdown of these particles as a result of traffic. It is assumed that the percent of silt-sized particles on a seasoned dirt road surface is approximately the same as that for gravel, or 12 percent. The mean number of days with 0.01 in. or more of rainfall for the sites surveyed ranged from 16 to 89.

Based on other information on the relationship between emissions and vehicle speed, the $\frac{s}{30}$ term in the equation was modified to $\frac{s}{30}^2$ for the unpaved parking lots. Further, it was assumed that 40 cars would be on each acre of parking (GCA 1978) and that the average distance traveled by a given vehicle would be the length of the longest side of the lot (½ the distance into the lot, ½ the distance exiting the lot).

For unpaved industrial roads it was assumed that a combination of controls would yield a 50% control efficiency. The range of calculated values for the three sources, then, were:

Source	Emission factor, lb/VMT	
	TSP	PM_{10}
Unpaved industrial roads	14.2-18.0	8.0-10.1
Other unpaved roads	3.0-3.8	1.7-2.1
Unpaved parking lots	0.4-0.5	0.22-0.28

AGRICULTURE

Total emissions from agriculture are calculated from the sum of tilling and wind erosion emissions. The emission factor for tilling from AP-42 (EPA 1983) is as follows:

$$E = K(538)(S)^{0.6} \qquad \text{(Eq. 3)}$$

where E = emission factor, lb/ac
K = particle size multiplier, TSP = 0.33, PM_{10} = 0.21
S = surface silt content of surface soil, s = 15 to 30 percent

Using this equation and the appropriate variable values, calculated emissions range from 901 to 1366 lb/acre for TSP and 574 to 870 for PM_{10}.

For wind erosion, an adaptation of the U.S. Department of Agriculture's wind erosion was used. The modified equation estimates annual suspended particulate emissions due to wind erosion from exposed soil surfaces (EPA 1974):

$$E = a\ I\ K\ C\ L'\ V' \qquad \text{(Eq. 4)}$$

where E = emission factor, tons/acre per year
a = portion of total wind erosion losses that would be measured as suspended particulate, estimated to be 0.025
I = soil erodibility, tons/acre per year
K = surface roughness factor
C = climatic factor
L' = unsheltered field width factor
V' = vegetative cover factor

In this equation, K, C, L', and V' are all dimensionless. All of the variables in the equation except "C" and "a" are dependent on the crop type grown on each field. The crop types were determined by visual observation during the microinventory. The "C" factors were calculated from the following equation:

$$C = 0.345\ \frac{W^3}{(PE)^2} \qquad \text{(Eq. 5)}$$

where C = climatic factor
W = mean annual wind velocity in mi/h at 30 feet
PE = Thornthwaite's precipitation evaporation index

Calculated C values ranged from 0.05 to 4.55 for the sites inventoried. The final calculated emission factor ranges for the five crop types identified are as follows:

Crop	Emission factor, tons/acre
Corn	0.005 to 2.01
Cotton	0.015 to 1.80
Beets	0.020 to 2.57
Wheat	0
Alfalfa	0

A PM_{10}/TSP ratio of 0.5 was used to calculate PM_{10} emissions from the TSP emissions. This ratio represents the median PM_{10}/TSP ratio for fugitive dust sources for which AP-42 includes particle size multipliers. Because of the approximate nature of this factor, it was rounded to one significant digit.

RAILROAD YARDS

Most of the emissions in train yards appear to be from wind erosion rather than from train movement. Therefore, the wind erosion equation described earlier was used as the basis for deriving emission factors for railroad yards. An average erodibility (I) of 86 tons/acre per year was assumed to be applicable for the soil in the railroad yards (EPA 1974). The area around railroad yards generally has a fairly smooth surface, which is equivalent to a K value of 1.0. The climatic factor for the Iowa sites ranged from 0.07 to 0.18. An average width of 1000 ft was assumed for railroad yards, since this is not a critical variable in the equation. The L' value equivalent to L = 1000 ft was determined from a nomograph in which soil type is also a variable 0.84. Because there is no vegetation in rail yards, V = 0 and V' = 1.0. Also, these areas are generally treated with oil or chemicals to reduce dust and weed problems. Therefore, the emissions have been estimated based on the above values and the following assumptions:

- No vegetation
- Half the area is stabilized, with an emission rate of 20 percent of the unstabilized area
- Train traffic increases the wind erosion emissions by 20 percent

Therefore, the resulting emission factor is:

$$E = (0.025)(86)(1.0)(C)\ (0.84)(1.0)\left(\frac{1 + 0.2}{2}\right)(1.2) \quad \text{(Eq. 6)}$$

$$= 0.07 \text{ to } 5.12 \text{ tons/acre-year}$$

For PM_{10} the 0.5 factor for the PM_{10}/TSP ratio described above was applied to the calculated results.

CLEARED OR EXPOSED AREAS

The modified wind erosion equation described earlier was used for estimating emissions from cleared or exposed areas. An average erodibility (I) of 47 or 86 tons/acre per year was assumed for the soil types common to these areas (EPA 1974). The cleared areas are generally left with a fairly smooth surface, which is equivalent to a K value of 1.0. The climatic factor for the study areas ranged from 0.05 to 4.55. An average field width of 1000 ft was assumed for all the cleared areas, since this is not a critical variable in the equation. The L' value equivalent to L = 1000 ft was determined from a nomograph in which soil type is also a variable. Because there is no vegetation on cleared areas, V = 0 and V' = 1.0.

Based on these input data, the average emission rate from cleared areas is between 0.09 and 8.22 tons/acre-year. For PM_{10} the 0.5 factor was multiplied by the calculated TSP emission to obtain estimated PM_{10} emissions.

CONSTRUCTION

The emission factor presented in AP-42 (EPA 1983) of 1.2 tons/acre per month is corrected for the climatic conditions at each site by use of the equation:

$$E = \frac{1.2}{(PE/50)^2} \qquad \text{(Eq. 7)}$$

where PE = varies from 6 to 39 at sites
E = 1.78-83.3 tons/acre per month

These values are appropriate for residential, commercial, and highway construction with excavation and regrading. Construction projects are assumed to be fugitive dust sources for 3 months a year if they are residential and 6 months a year if commercial, industrial, or highway. The PM_{10} emissions were obtained by multiplying the calculated TSP emissions by 0.5.

UNPAVED STORAGE AREAS

No emission factor was found for this source category. By comparison with other source categories, it was estimated that annual emissions per acre for this source were less than either cleared areas or railroad yards. Consequently, it was estimated that emissions from storage areas would be 25 percent of those for a cleared area. The PM_{10}/TSP factor of 0.5 was applied to the calculated TSP emissions to obtain the PM_{10} emissions.

REFERENCES FOR APPENDIX B

Environmental Protection Agency. 1974. Development of Emission Factors for Fugitive Dust Sources. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. Publication No. EPA-450/3-74-037.

Environmental Protection Agency. 1983. Compilation of Air Pollutant Emission Factors. 3d ed. (including supplements 1-14). AP-42.

GCA Corporation. 1978. Inventory Development for Evaluation of Measures for the Control of Nontraditional Sources of Particulates in Southern New England. (Draft final report). GCA Corporation, GCA/Technology Division, Bedford, Massachusetts.

APPENDIX C

MICROINVENTORY RESULTS

DESCRIPTION OF SITE (Number 1)

SAROAD code - 030440006

Location - Maricopa County--Carefree Airport

UTM coordinates - 416.96 3742.15

Monitor height - monitor no longer active

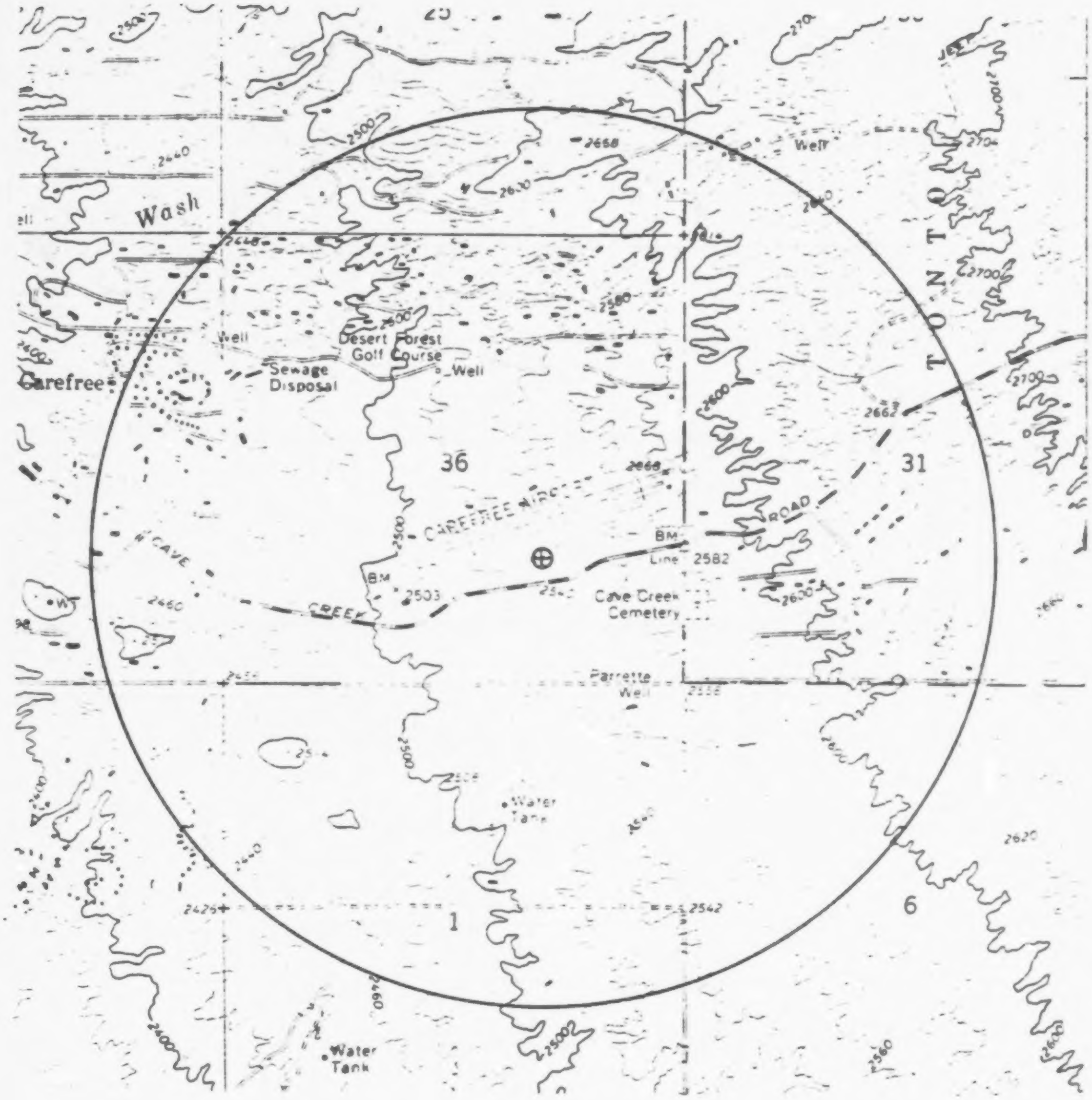
Topography - desert landscape

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Unpaved area	Adjacent to monitor site	Little or no traffic

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
A07	1980	30.0	0	0	21	0	0
A07	1981	43.0	25.7	0	36	37	0
A07	1982	46.0	21.2	0	43	49	0


Wash
Carefree
Well
Sewage Disposal
Desert Forest Golf Course
Well
36
31
CAREFREE AIRPORT
ROAD
CAVE
CREEK
BM
2503
BM
Line 2582
Cave Creek Cemetery
Parrette Well
Water Tank
1
6
Water Tank
TONTO

One mile radius around Maricopa County, Carefree Airport. (Site 1)

AREA SOURCE SUMMARY (Site 1)

Site: Carefree Airport

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators							0.1			0.2	0.3
Rail/Air		0.2	0.1	0.1							0.4
FUGITIVE DUST:											
Railroad yards											
Clean streets	2X10^{6}VMT	1.1	1.6	1.1	0.7		2.5	1.8	1.5	3.5	13.8
Unpaved rds/alleys	23X10^{3}VMT	6.6	1.3	8.2			3.3	4.9	16.4		40.7
Cleared areas											
Construction											
Agriculture											
Storage areas	1.7 ac		0.8								0.8
Unpaved pkg lots	1X10^{3}VMT		0.3								0.3

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.2	0.2	0.3	0.7
FUGITIVE DUST	7.7	14.0	33.9	55.6
Total	7.9	14.2	34.2	56.3

AREA SOURCE SUMMARY (Site 1)

Site: Carefree Airport

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators								0.1		0.2	0.3
Rail/Air		0.2	0.1	0.1							0.4
FUGITIVE DUST:											
Railroad yards											
Clean streets	$2X10^6$VMT	0.6	0.9	0.6	0.4		1.5	1.1	0.9	2.1	8.1
Unpaved rds/alleys	$23X10^3$VMT	3.7	0.7	4.6			1.8	2.7	9.2		22.7
Cleared areas											
Construction											
Agriculture											
Storage areas	1.7 ac		0.4								0.4
Unpaved pkg lots	$1X10^3$VMT		0.2								0.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.2	0.2	0.3	0.7
FUGITIVE DUST	4.3	7.8	19.3	31.4
Total	4.5	8.0	19.6	32.1

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
	NONE						

DESCRIPTION OF SITE (Number 2)

SAROAD code - 030300001

Location - Hayden Jail, on Canyon Drive one block west of Utah Avenue, Hayden,
Arizona

UTM coordinates - 520.0 3651.7

Monitor height - 18 ft., on roof of building

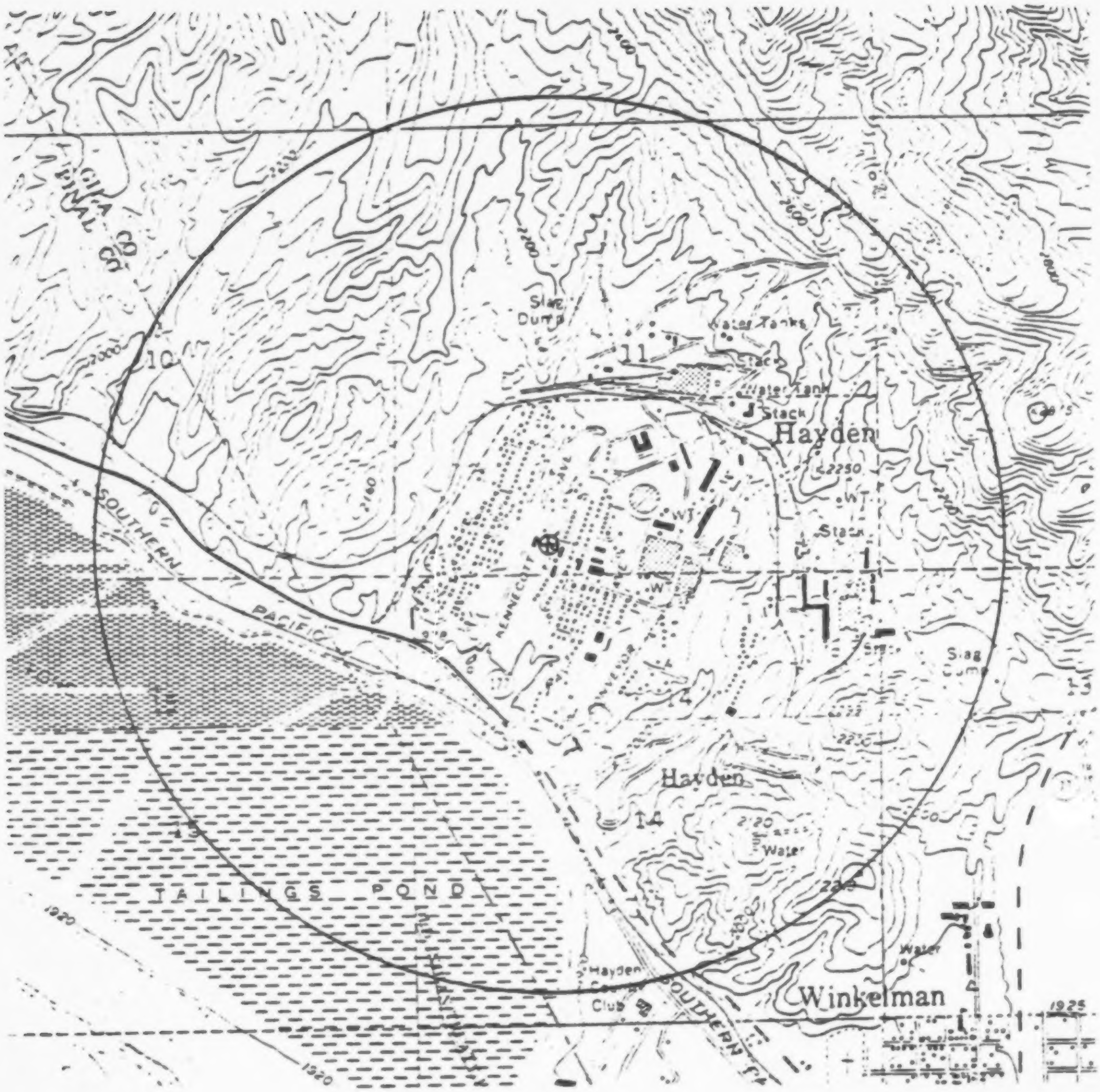
Topography - complex terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Canyon Drive	24 ft.	Paved 2000 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
F02	1982	172.3	0	0	52	0	0
F02	1983	119.2	0	0	51	0	0


GILA CO
PINAL CO
2400
2100
2600
Slag Dump
Water Tanks
11
10
Stack
Water Tank
Stack
Hayden
2250
Stack
Slag Dump
SOUTHERN PACIFIC
Hayden
14
2120
Water
TAILINGS POND
Hayden Country Club
SOUTHERN PA
Winkelman
Water
1920
1925
2000
2100

One mile radius around Gila County, Hayden, Arizona. (Site 2)

AREA SOURCE SUMMARY (Site 2)

Site: Hayden

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.6									0.6
Comm/Ind fuel		0.1									0.1
Incinerators											
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$3X10^6$VMT	4.2	0.1	2.6	3.7			2.7	2.5	1.2	17.0
Unpaved rds/alleys	Reference	172.5	106.4	96.3	73.5	0.9	93.4	203.3	87.1		833.4
Cleared areas	992 ac	2.5	23.5	9.5				87.5	75.0	50.0	248.0
Tailings Piles	320 ac	0.4		1.5	0.6	0.4			45.0		47.9
Agriculture											
Storage areas											
Unpaved pkg lots	$5X10^3$VMT	1.2									1.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.7			0.7
FUGITIVE DUST	180.8	319.0	647.7	1147.5
Total	181.5	319.0	647.7	1148.2

AREA SOURCE SUMMARY (Site 2)

Site: **Hayden**

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.4									0.4
Comm/Ind fuel		0.1									0.1
Incinerators											
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$3X10^6$VMT	2.5	0.1	1.5	2.2			1.6	1.5	0.7	10.1
Unpaved rds/alleys	Reference	96.6	54.3	49.1	37.5	0.5	47.6	103.7	44.4		433.7
Cleared areas	992 ac	1.3	12.0	4.8				44.6	38.2	25.5	126.4
Tailings Piles	320 ac	0.2		0.8	0.3	0.2			23.0		24.5
Agriculture											
Storage areas											
Unpaved pkg lots	$5X10^3$VMT	0.7									0.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.5			0.5
FUGITIVE DUST	101.3	163.3	330.8	595.4
Total	101.8	163.3	330.8	595.9

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	ASARCO Smelter	1560	1435	0.7	2	520.9	3651.5
2	Kennecott Smelter	*	*	0.5	1	520.6	3652.3

*Plant has not been in operation since April 1982.

DESCRIPTION OF SITE (Number 3)

SAROAD code - 030600002

Location - 1845 Roosevelt St., Phoenix Arizona

UTM coordinates - 403.2 3702.4

Monitor height - 30 feet

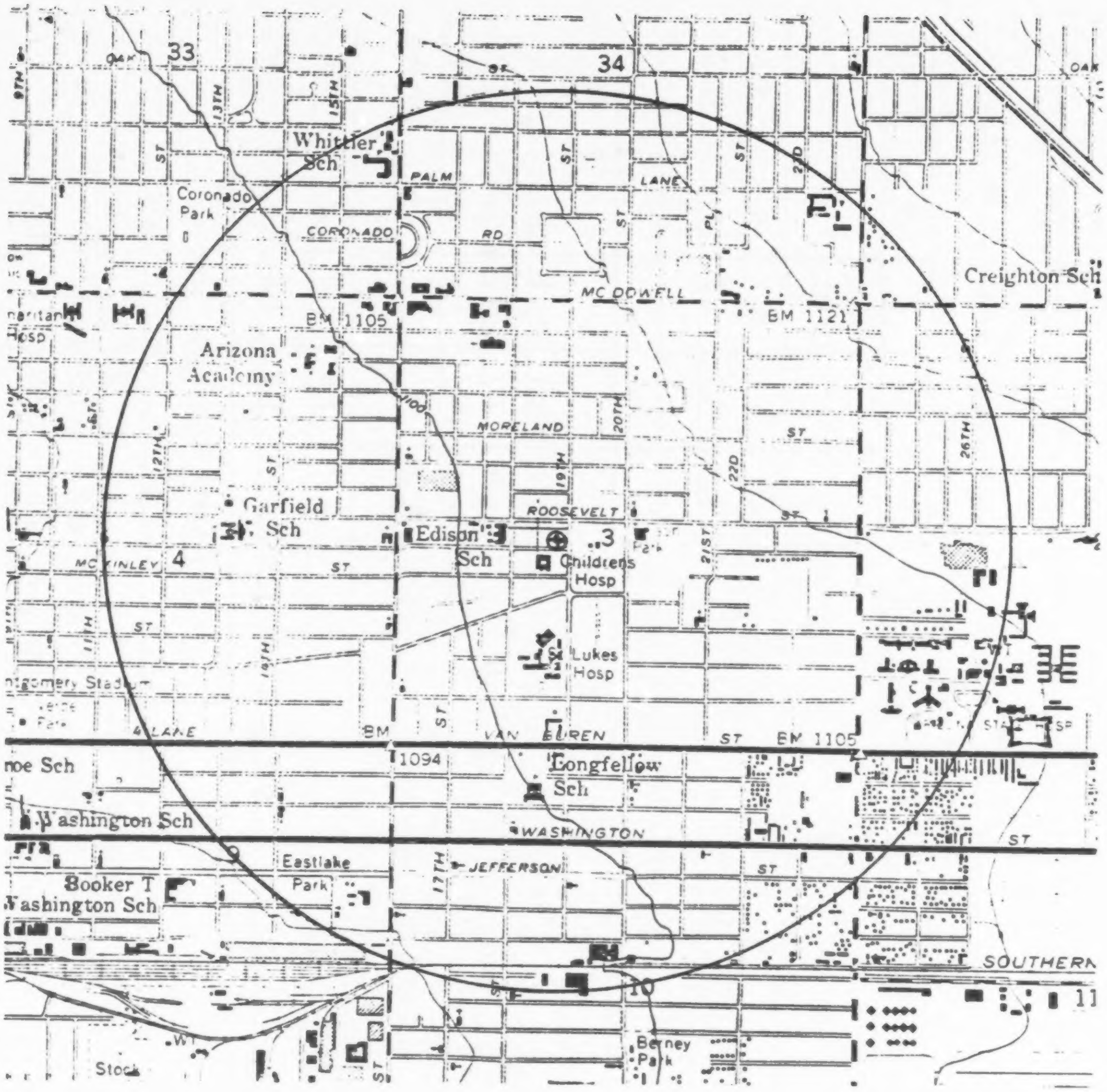
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
19th Street	75 feet	Paved, 2000 ADT
Garfield Street	93 feet	Paved, 8000 ADT
Roosevelt Street	157 feet	Paved, 12200 ADT
Paved Parking	24-33 feet	N and S of monitor

Air quality data -

		Annual arithmetic mean, μg/m³			No. of samples		
Monitor	Year	TSP	IP	PM_{10}	TSP	IP	PM_{10}
A07	1980	121	0	0	39	0	0
A07	1981	108	83	0	43	37	0
A07	1982	101.1	54	0	53	43	0
G01	1982	95	0	0	55	0	0
G01	1983	106	0	0	40	0	0


33
34
Whittier Sch
PALM
LANE
Coronado Park
CORONADO
RD
MC DOWELL
Creighton Sch
BM 1105
BM 1121
Arizona Academy
MORELAND
ST
20TH
19TH
22D
26TH
Garfield Sch
Edison Sch
ROOSEVELT
3
Childrens Hosp
21ST
MC KINLEY
4
St Lukes Hosp
19TH
17TH
VAN BUREN
BM 1105
1094
Longfellow Sch
WASHINGTON
Washington Sch
JEFFERSON
Eastlake Park
Booker T Washington Sch
SOUTHERN
10
11
Berney Park
Stock

One mile radius around 1845 Roosevelt, Phoenix, Arizona. (Site 3)

AREA SOURCE SUMMARY (Site 3)

Site: 1845 Roosevelt Street

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel							0.1	0.1	0.1	0.1	0.4
Incinerators		1.4			1.1		4.3	4.3	4.3	4.3	19.7
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$126X10^6$VMT	37.3	19.0	23.5	39.4	31.4	156.8	156.1	136.1	154.4	754.0
Unpaved rds/alleys	$26X10^3$VMT	2.6	3.1		1.6	1.1	5.0	3.7	9.3	0.6	27.0
Cleared areas	151 ac	6.1	11.2	8.3	0.7	6.0	14.6	11.7	2.7	6.8	68.1
Construction	62 ac	118.6	348.8	258.1	17.4	55.8	62.8				861.5
Agriculture											
Storage areas	9 ac							1.0	1.0		2.0
Unpaved pkg lots	$20X10^3$VMT	0.1		0.7	0.5	1.1		1.1	1.0	0.3	4.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.4	1.1	17.6	20.1
FUGITIVE DUST	164.7	827.7	725.0	1717.4
Total	166.1	828.8	742.6	1737.5

AREA SOURCE SUMMARY (Site 3)

Site: 1845 Roosevelt Street

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators							0.1	0.1	0.1	0.1	0.4
Rail/Air		1.0			0.8		3.2	3.2	3.2	3.2	14.6
FUGITIVE DUST:											
Railroad yards											
Clean streets	$126X10^6$VMT	22.0	11.2	13.9	23.2	18.5	92.5	92.1	80.3	91.1	444.8
Unpaved rds/alleys	$26X10^3$VMT	1.4	1.7		0.9	0.6	2.8	2.1	5.2	0.3	15.0
Cleared areas	151 ac	3.1	5.7	4.2	0.4	3.1	7.4	5.9	1.4	3.5	34.7
Construction	62 ac	60.4	178.0	131.6	8.9	28.4	32.0				439.3
Agriculture											
Storage areas	9 ac							0.5	0.5		1.0
Unpaved pkg lots	$20X10^3$VMT	0.1		0.4	0.3	0.6		0.6	0.6	0.2	2.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.0	0.8	13.2	15.0
FUGITIVE DUST	87.0	431.9	419.0	937.6
Total	88.0	432.7	432.2	952.6

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Arizona Sand and Rock	70	35	2.5	2	403.2	3698.3
2	Union Rock	75	38	3.2	3	400.2	3698.1
3	United Metro, 40th Street	65	32	3.4	2	407.3	3698.7
4	United Metro, 19th Avenue	61	30	4.6	3	397.7	3697.4
5	Garret Air Turbine, Inc.	31	30	2.4	2	406.7	3700.7
6	Gold Bond Building Products	31	23	1.2	3	402.1	3700.7
7	Sea Ray Boats	1	1	4.4	2	408.0	3697.3

DESCRIPTION OF SITE (Number 4)

SAROAD code - 030600013

Location - 4732 S. Central Avenue, Phoenix, Arizona

UTM coordinates - 400.2 3696.5

Monitor height - 30 feet

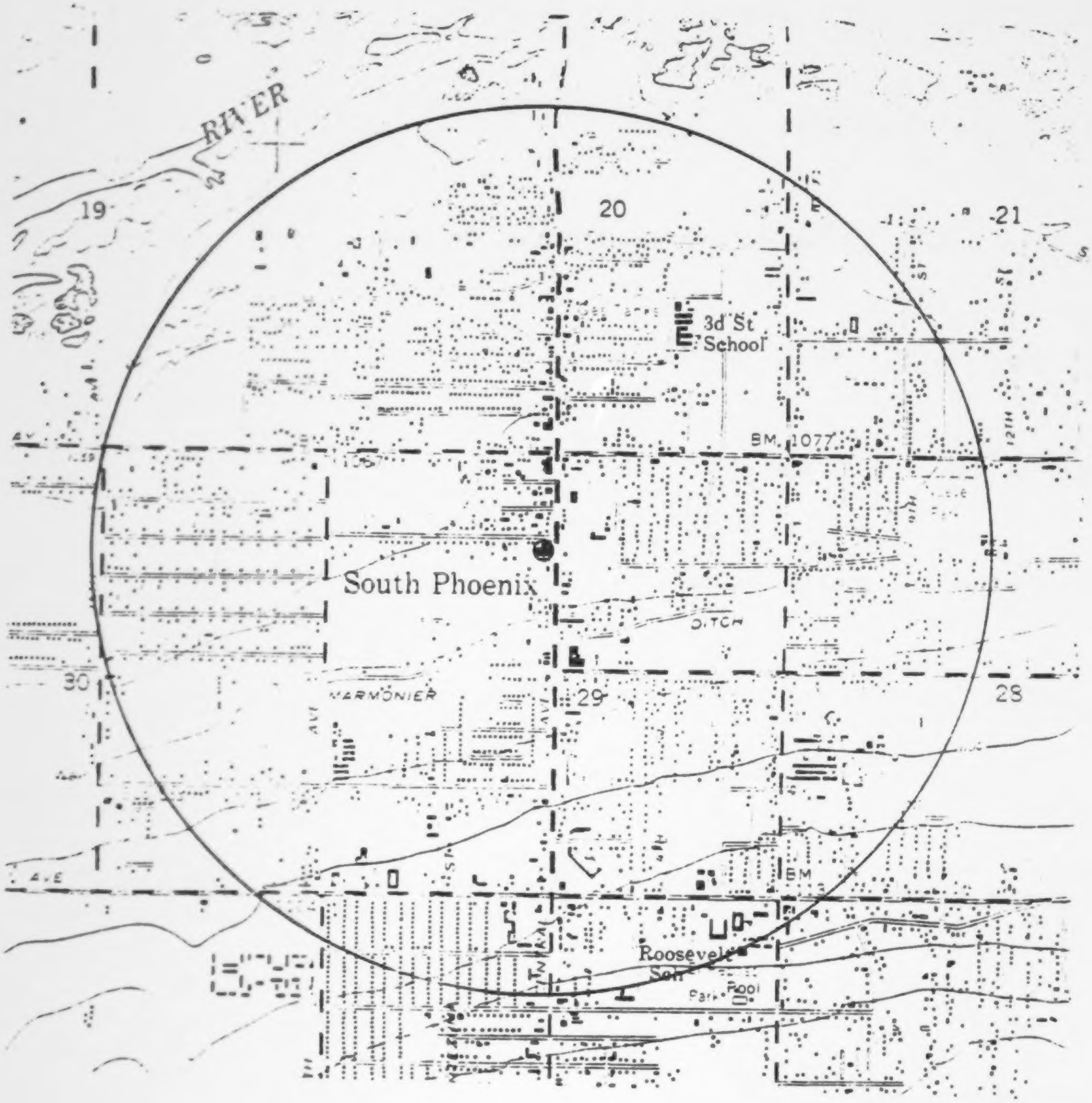
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Central Avenue	130 feet	Paved, 17000 ADT
Tamarisk Avenue	175 feet	Paved, 1000 ADT
Paved Parking	70 feet	S and W of site

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
G01	1982	128	0	0	61	0	0
G01	1983	113.2	0	0	40	0	0


RIVER
19
20
21
3d St School
BM 1077
South Phoenix
DITCH
HARMONIER
30
29
28
BM
Roosevelt Sch
Park Pool

One mile radius around 4732 S. Central, Phoenix, Arizona. (Site 4)

AREA SOURCE SUMMARY (Site 4)

Site: 4732 S. Central

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel		0.1					0.1	0.1	0.1		0.4
Incinerators		1.0	0.5	0.5	0.5	0.5	2.2	2.2	2.2	2.2	11.8
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	51×10^6 VMT	27.9	19.4	17.0	10.2	15.5	64.6	61.8	57.1	30.1	303.6
Unpaved rds/alleys	34×10^3 VMT	1.6	3.6	0.9	4.7	2.5	0.6	1.6	9.7	22.9	48.1
Cleared areas	88 ac		0.4			0.9	0.9	7.2	4.7	25.2	39.3
Construction	2 ac	55.8									55.8
Agriculture											
Storage areas	21 ac	0.2					3.6			0.9	4.7
Unpaved pkg lots	10×10^3 VMT	0.4	0.1			0.1	0.2	0.7	0.5	0.2	2.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.1	2.0	9.1	12.2
FUGITIVE DUST	85.9	75.3	292.5	453.7
Total	87.0	77.3	301.6	465.9

AREA SOURCE SUMMARY (Site 4)

Site: 4732 S. Central

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel		0.1					0.1	0.1	0.1		0.4
Incinerators		1.0	0.5	0.5	0.5	0.5	2.2	2.2	2.2	2.2	1.8
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	51×10^6 VMT	16.5	11.4	10.0	6.0	9.1	38.1	36.5	33.7	17.8	179.1
Unpaved rds/alleys	34×10^3 VMT	0.9	2.0	0.5	2.6	1.4	0.3	0.9	5.4	12.8	26.8
Cleared areas	88 ac		0.2			0.5	0.5	3.7	2.4	12.9	20.2
Construction	2 ac	28.5									28.5
Agriculture											
Storage areas	21 ac	0.1					1.8			0.5	2.4
Unpaved pkg lots	10×10^3 VMT	0.2	0.1			0.1	0.1	0.4	0.3	0.1	1.3

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.1	2.0	9.1	12.2
FUGITIVE DUST	46.2	43.9	168.2	258.3
Total	47.3	45.9	177.3	270.5

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Arizona Sand and Rock	70	35	2.2	1	403.2	3698.3
2	Union Rock	75	38	1.0	1	400.2	3698.1
3	United Metro, 40th Street	65	32	4.6	1	407.3	3698.7
4	United Metro, 19th Avenue	61	30	1.6	4	397.7	3697.4
5	Phoenix Redi-Mix Co., Inc.	39	20	4.5	4	393.0	3697.7
6	Garret Air Turbine, Inc.	31	30	4.8	1	406.7	3700.7
7	Gold Bond Building Products	31	23	2.8	1	402.1	3700.7
8	Searle Labs	1	1	4.0	4	394.4	3699.5
9	Sea Ray Boats	1	1	4.9	1	408.0	3697.3

DESCRIPTION OF SITE (Number 5)

SAROAD code - 030680001

Location - County Jail, 521 10th Avenue, Safford, AZ

UTM coordinates - 618.8 3633.5

Monitor height - 12 ft., on roof of building

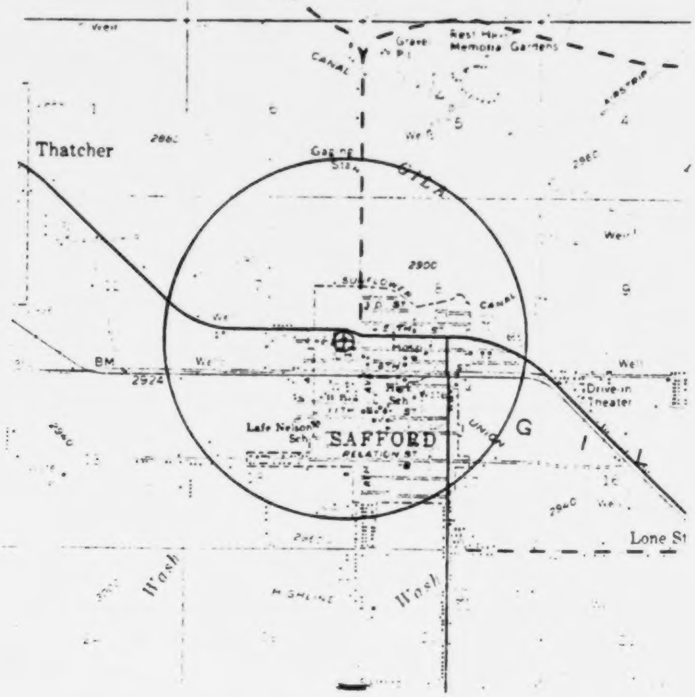
Topography - No special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
10th Street	105 feet	Paved, 2500 ADT
unnamed road	20 feet	Unpaved, 100 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, $\mu g/m^3$ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
F01	1982	122	0	0	59	0	0
F01	1983	110	0	0	56	0	0


Grave Pit
Rest Haven Memorial Gardens
CANAL
Thatcher
GILA
2900
Well
BM
2924
Drive-in Theater
Lafe Nelson Sch
SAFFORD
RELATION ST
UNION
Lone St
Wash
Wash
2960

One mile radius around Safford, 521 10th Avenue. (Site 5)

AREA SOURCE SUMMARY (Site 5)

Site: Safford

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators											
Rail/Air		0.4	0.3	0.3	0.3		1.3	1.3	1.3		5.2
FUGITIVE DUST:											
Railroad yards											
Clean streets	15X10^{6}VMT	14.9	7.9	2.8	2.8	5.5	9.6	24.5	8.6	13.4	90.0
Unpaved rds/alleys	16X10^{3}VMT	2.7	2.4		0.1		6.5	7.2	3.8		22.7
Cleared areas	23 ac					0.6	8.7	0.6	3.4	2.8	16.1
Construction											
Agriculture	1234 ac	7.8	25.9		39.2	52.6	210.2	41.4	224.2	263.4	864.7
Storage areas											
Unpaved pkg lots	19X10^{3}VMT	1.6	0.1	0.6	0.4	0.1	0.1	1.2	0.3	0.1	4.5

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.4	0.9	3.9	5.2
FUGITIVE DUST	27.0	141.0	830.0	998.0
Total	27.4	141.9	833.9	1003.2

AREA SOURCE SUMMARY (Site 5)

Site: Safford

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators		0.3	0.2	0.2	0.2		1.0	1.0	1.0		3.9
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$15X10^6$VMT	8.8	4.7	1.7	1.7	3.2	5.7	14.5	5.1	7.9	53.3
Unpaved rds/alleys	$16X10^3$VMT	1.5	1.3		0.1		3.6	4.0	2.1		12.6
Cleared areas	23 ac					0.3	4.4	0.3	1.7	1.4	8.1
Construction											
Agriculture	1234 ac	3.7	12.2	18.5		24.8	99.1	19.5	105.7	124.2	407.7
Storage areas											
Unpaved pkg lots	$19X10^3$VMT	0.9	0.1	0.3	0.2	0.1	0.1	0.7	0.2	0.1	2.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.3	0.6	3.0	3.9
FUGITIVE DUST	14.9	69.2	400.3	484.4
Total	15.2	69.8	403.3	488.3

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Safford No. 2 Gin	5	2	0.8	2	622.0	3633.1

DESCRIPTION OF SITE (Number 6)

SAROAD code - 030960002

Location - 201 South 2nd Avenue, Yuma, AZ

UTM coordinates - 722.9 3622.9

Monitor height - 20 feet

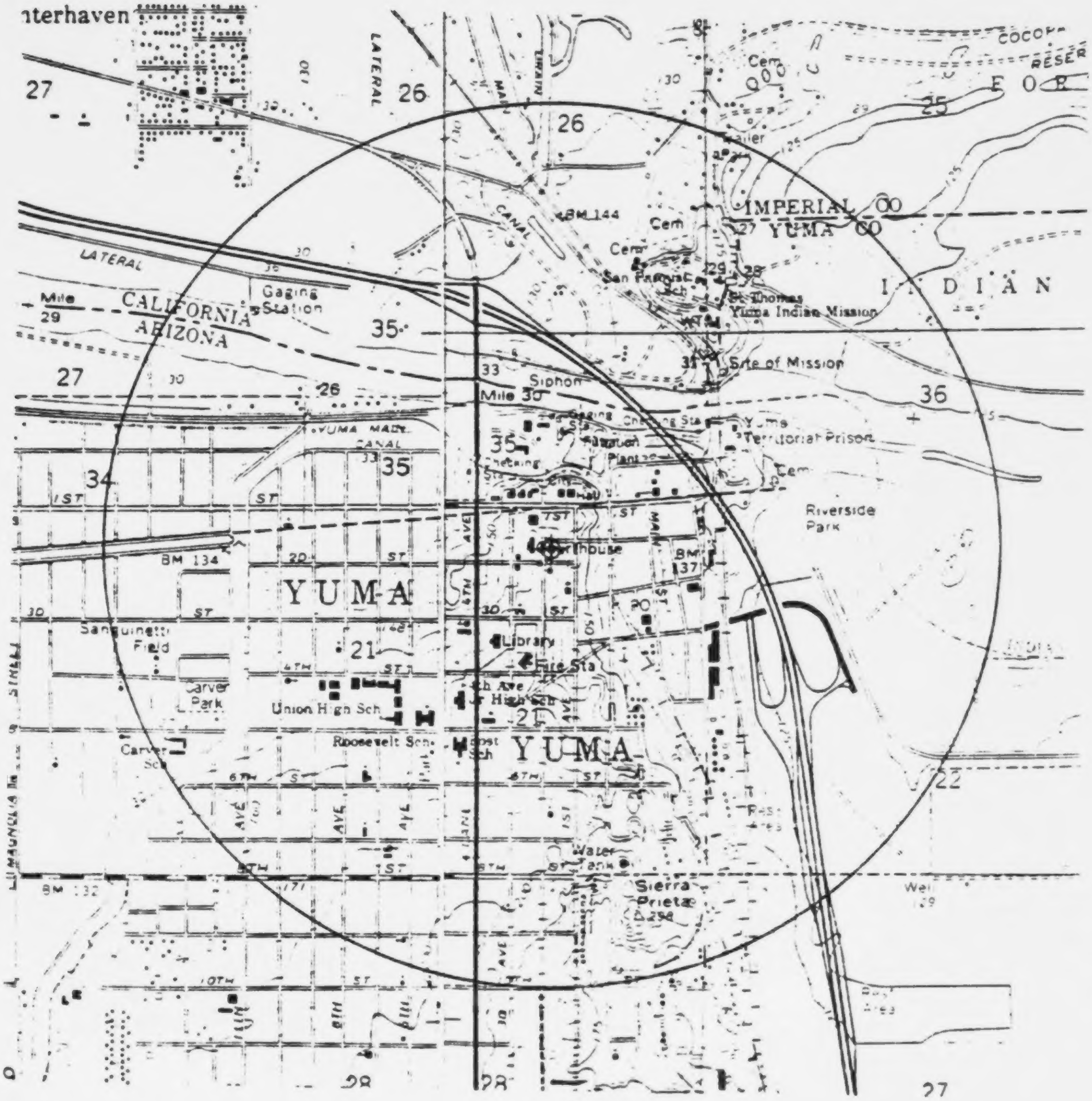
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
2nd Street	78 feet	Paved, 1000 ADT
2nd Avenue	78 feet	Paved, 1200 ADT
Unpaved lot	Adjacent	Adjoins east side of building on which monitor is mounted

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
F01	1982	100.9	0	0	59	0	0
F01	1983	118.8	0	0	53	0	0



nterhaven
CALIFORNIA
ARIZONA
IMPERIAL CO
YUMA CO
INDIAN
YUMA
YUMA
St. Thomas Yuma Indian Mission
Site of Mission
Yuma Territorial Prison
Riverside Park
Courthouse
Library
Fire Sta
Union High Sch
Roosevelt Sch
Carver Park
Sanguinetti Field
Gaging Station
Siphon
Water Tank
Sierra Prieta
Cem

One mile radius around 201 S. 2nd Avenue, Yuma, Arizona. (Site 6)

AREA SOURCE SUMMARY (Site 6)

Site: Yuma

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.4	0.2	0.3	0.3	0.2		0.2	1.0	0.2	2.8
Comm/Ind fuel											
Incinerators		0.6	0.1	0.4	0.4	0.1	1.7	1.7	1.7	1.7	8.4
Rail/Air			0.1	0.3			0.3	0.6		0.1	1.4
FUGITIVE DUST:											
Railroad yards	70 ac	9.0	10.2	51.2		10.2	71.7	153.6		51.2	357.1
Clean streets	17X10^{6}VMT	14.0	10.4	2.0	9.4	3.0	2.2	13.7	30.5	17.9	103.1
Unpaved rds/alleys	90X10^{3}VMT	10.3	9.5	4.3	0.1	21.0	6.1	41.4	9.3	37.0	139.0
Cleared areas	255 ac	82.2	131.5	139.7	82.2	106.9	123.3	739.8	378.1	312.4	2096.1
Construction											
Agriculture	123 ac						154.9	101.3		222.3	478.5
Storage areas	2 ac								4.1		4.1
Unpaved pkg lots	33X10^{3}VMT	0.7	0.1	0.9	0.5		0.9	1.0	3.9	0.2	8.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.0	2.4	9.2	12.6
FUGITIVE DUST	116.2	593.1	2476.8	3186.1
Total	117.2	595.5	2486.0	3198.7

AREA SOURCE SUMMARY (Site 6)

Site: Yuma

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.3	0.2	0.2	0.2	0.2		0.2	0.8	0.2	2.3
Comm/Ind fuel											
Incinerators		0.5	0.1	0.3	0.3	0.1	1.3	1.3	1.3	1.3	6.5
Rail/Air			0.1	0.2			0.2	0.5		0.1	1.1
FUGITIVE DUST:											
Railroad yards	70 ac	4.6	5.2	26.1		5.2	36.6	78.3		26.1	182.1
Clean streets	17X10^{6}VMT	8.2	6.1	1.2	5.5	1.8	1.3	8.1	18.0	10.6	50.2
Unpaved rds/alleys	90X10^{3}VMT	5.8	5.3	2.4	0.1	11.8	3.4	23.2	5.2	20.7	77.9
Cleared areas	255 ac	41.9	67.1	71.2	41.9	54.5	62.9	377.3	192.8	159.3	1068.9
Construction											
Agriculture	123 ac						77.9	56.0		111.9	245.8
Storage areas	2 ac								2.1		2.1
Unpaved pkg lots	33X10^{3}VMT	0.4	0.1	0.5	0.3		0.5	0.6	2.2	0.1	4.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.8	1.9	7.2	9.9
FUGITIVE DUST	60.9	306.3	1275.1	1642.3
Total	61.7	308.2	1282.3	1652.2

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Yucca Generating Station	16	16	4.7	3	715.3	3622.5
2	Prod. Cotton Oil	4	3	4.1	3	720.3	3616.9
3	Northrup King Co.	6	4	1.7	2	723.6	3620.3
4	Valley Sand and Gravel	1	1	1.3	2	723.0	3620.8
5	Farmer's Marketing Corp.	1	1	1.7	2	723.8	3620.3
6	Barkley Seed and Grain	2	1	2.2	2	724.4	3619.7
7	Yuco Gin, Inc.	23	12	4.0	3	726.8	3616.8
8	Federal Compress	1	1	3.5	2	726.8	3618.8
9	Best Block Pipe Company	16	8	2.1	2	724.7	3620.1

DESCRIPTION OF SITE (Number 7)

SAROAD code - 050520003

Location - 225 Chester Avenue

UTM coordinates - 316.6 3914.4

Monitor height - 35 feet

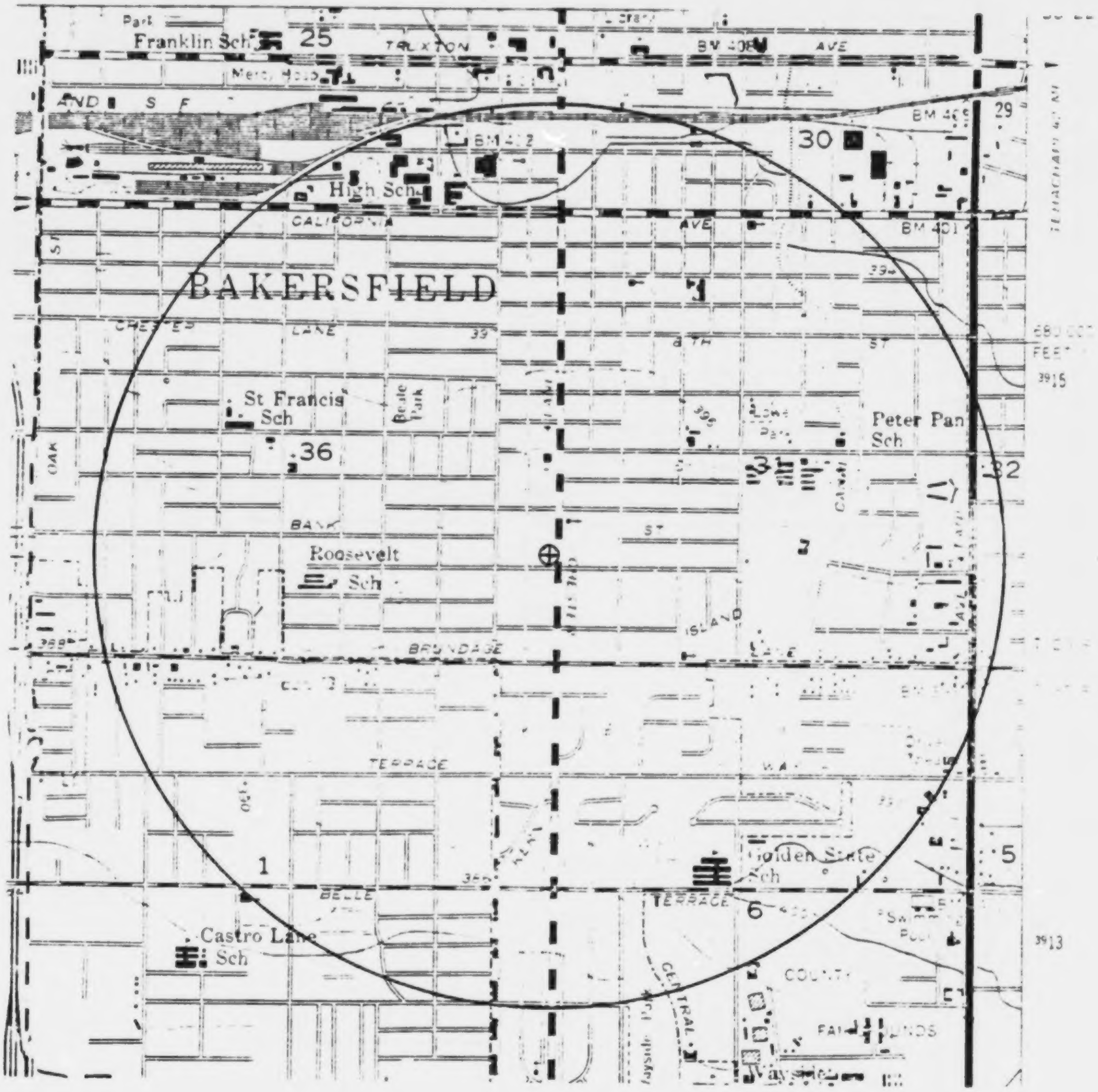
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Chester Avenue	45 feet	Paved commercial 4 lane street, 18150 ADT
2nd Street	175 feet	Paved residential street, 100 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
F01	1982	125.9	0	0	37	0	0
F01	1983	103.2	0	0	20	0	0
A07	1980	221.5	160.6	0	8	4	0
A07	1981	118.2	63.6	0	30	25	0
A07	1982	87.4	50.3	0	17	20	0


Franklin Sch
25
TRUXTON
AVE
BM 408
29
30
BM 402
High Sch
CALIFORNIA
AVE
BM 401
BAKERSFIELD
CHESTER
LANE
St Francis Sch
Beale Park
36
Peter Pan Sch
31
32
BANK
ST
Roosevelt Sch
ISLAND
BRUNDAGE
TERRACE
1
BELLE
TERRACE
Golden State Sch
6
5
Castro Lane Sch
CENTRAL
COUNTY
FAIRGROUNDS
Wayside
OAK

One mile radius around 225 Chester Avenue, Bakersfield, California. (Site 7)

AREA SOURCE SUMMARY (Site 7)

Site: 225 Chester Avenue

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.2	0.2	0.2	0.2	0.7	0.7	0.7	0.7	3.8
Comm/Ind fuel							0.1	0.1	0.1	0.1	0.4
Incinerators		0.5	0.4	0.4	0.4	0.4	1.4	1.4	1.4	1.4	7.7
Rail/Air							0.2			0.2	0.4
FUGITIVE DUST:											
Railroad yards	7 ac						0.3			0.2	0.5
Clean streets	83X10^{6}VMT	56.1	16.9	30.9	29.5	11.2	111.4	83.7	56.8	99.4	495.9
Unpaved rds/alleys	2X10^{3}VMT					0.1	0.2	0.1	0.1		0.5
Cleared areas	53.4 ac	0.3		0.2	0.4	0.2	0.9	1.1	1.4	0.3	4.8
Construction	3.8 ac	6.0					2.7			11.7	20.4
Agriculture											
Storage areas											
Unpaved pkg lots	13X10^{3}VMT	0.2		0.4	0.2		0.1	2.2	0.1		3.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.7	2.4	9.2	12.3
FUGITIVE DUST	62.6	90.0	372.7	525.3
Total	63.3	92.4	381.9	537.6

AREA SOURCE SUMMARY (Site 7)

Site: 225 Chester Avenue

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	3.0
Comm/Ind fuel							0.1	0.1	0.1	0.1	0.4
Incinerators		0.4	0.3	0.3	0.3	0.3	1.0	1.0	1.0	1.0	5.6
Rail/Air							0.2			0.2	0.4
FUGITIVE DUST:											
Railroad yards	7 ac						0.2			0.1	0.3
Clean streets	$83X10^6$VMT	33.1	10.0	18.2	18.2	6.6	65.7	49.4	33.5	58.6	293.3
Unpaved rds/alleys	$2X10^3$VMT					0.1	0.1	0.1	0.1		0.4
Cleared areas	53.4 ac	0.2		0.1	0.2	0.1	0.5	0.6	0.7	0.2	2.6
Construction	3.8 ac	3.1					1.4			6.0	10.5
Agriculture											
Storage areas											
Unpaved pkg lots	$13X10^3$VMT	0.1		0.2	0.1		0.1	1.2	0.1		1.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.6	2.0	6.8	9.4
FUGITIVE DUST	36.5	55.2	217.2	308.9
Total	37.1	57.2	224.0	318.3

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	IMC Corp.	38.3	37.5	2.5	4	313.4	3916.8
2	Dicco, Inc.	54.0	27.0	1.0	4	316.6	3916.0
3	Getty Refining	59.1	54.4	3.4	4	311.6	3916.5
4	Pacific Foundries	9.0	8.3	1.8	4	314.8	3916.6
5	San Joaquin Refining	40.0	36.8	3.0	4	314.3	3918.7
6	Sunland Refining	3.3	3.2	4.3	4	310.1	3916.5
7	Tosco Corp.	163.4	161.6	3.1	4	314.2	3918.8
8	West Coast Oil Co.	43.2	40.0	4.6	1	318.7	3921.5
9	PG & E	112.1	87.3	4.6	4	309.7	3916.9
10	Mobil Chemical	4.0	2.9	4.7	4	313.5	3921.3
11	Chevron USA	4.8	4.5	4.6	1	318.3	3921.5
12	Golden Bear Refinery	51.8	47.7	4.3	1	317.4	3921.2
13	B & R Oil Co.	0.1	0.1	2.3	4	316.5	3918.5
14	Consolidated Fiberglass	41.0	37.7	2.9	4	314.2	3918.4
15	Gibson Oil & Refining Co.	0.2	0.2	2.6	4	313.3	3916.8

DESCRIPTION OF SITE (Number 8)

SAROAD code - 050840003

Location - 401 Main Street, Brawley, CA

UTM coordinates - 637.1 3649.6

Monitor height - 26 feet

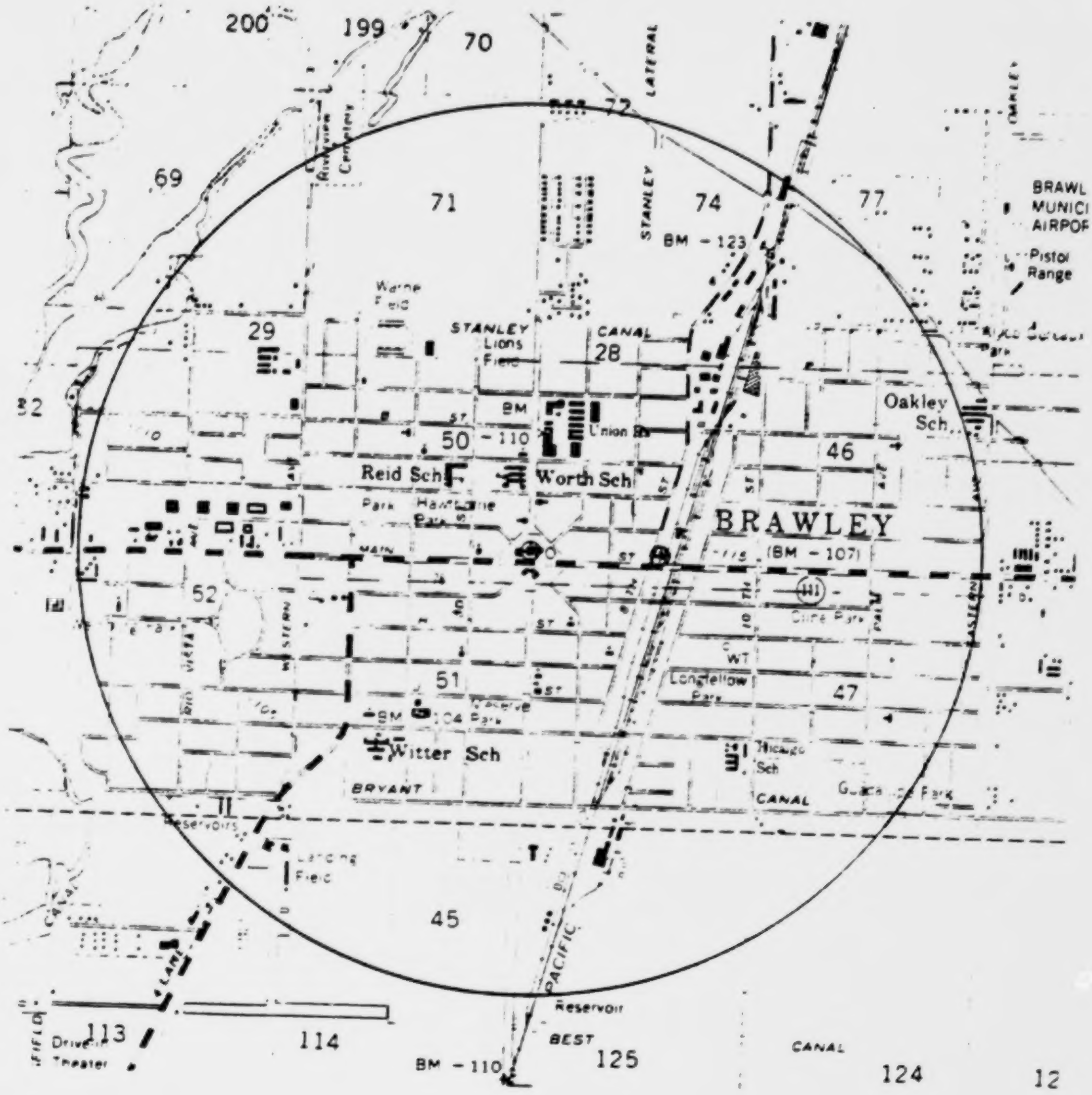
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Main Street	132 feet	Paved, 15200 ADT
Fourth Street	147 feet	Paved, 2500 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, μg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
I01	1982	145.4	0	0	25	0	0
I01	1983	143.9	0	0	9	0	0


200
199
70
72
LATERAL
OAKLEY
69
71
74
77
STANLEY
BM – 123
BRAWL
MUNICI
AIRPOF
Pistol Range
Warne Field
29
STANLEY
CANAL
Lions Field
28
32
Oakley Sch
BM
50
– 110
Union Sh
Reid Sch
Worth Sch
46
Hawthorne Park
BRAWLEY
(BM – 107)
111
52
51
BM
104
Longfellow Park
47
Witter Sch
Hidalgo Sch
BRYANT
CANAL
Reservoirs
Landing Field
45
PACIFIC
Reservoir
BEST
113
Drive-in Theater
114
BM – 110
125
CANAL
124
12

One mile radius around 4th and Main Streets, Brawley Post Office. (Site 8)

AREA SOURCE SUMMARY (Site 8)

Site: Brawley

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.8	0.6	0.6	0.6	0.6	2.4	2.4	2.4	2.4	12.8
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.3
Incinerators		1.1	0.8	0.8	0.8	0.8	3.4	3.4	3.4	3.4	17.9
Rail/Air			0.1	0.1			0.5	0.5			1.2
FUGITIVE DUST:											
Railroad yards	37.8 ac		13.1	13.5			7.3	7.3			41.2
Clean streets	22X10^{6}VMT	23.0	7.7	15.9	15.6	1.2	16.2	27.6	19.3	5.6	132.1
Unpaved rds/alleys	27X10^{3}VMT		43.6	0.1	0.1		66.4	30.1	2.8	2.6	145.7
Cleared areas	90.8 ac	1.4	5.5	8.2	1.8	1.8	22.8	25.6	3.7	4.6	75.4
Construction	6.5 ac						114.8		45.9	137.8	298.5
Agriculture	310 ac						27.3	34.2	21.8	94.1	177.4
Storage areas	5.5 ac						0.8		0.3		1.1
Unpaved pkg lots	63X10^{3}VMT	0.2	1.5	2.2	0.2	0.3	7.8	1.6	0.6	1.4	15.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	2.0	6.2	25.0	33.2
FUGITIVE DUST	24.6	132.3	730.3	887.2
Total	26.6	138.5	755.3	920.4

AREA SOURCE SUMMARY (Site 8)

Site: Brawley

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.6	0.4	0.4	0.4	0.4	1.8	1.8	1.8	1.8	9.4
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.3
Incinerators		0.8	0.6	0.6	0.6	0.6	2.6	2.6	2.6	2.6	13.6
Rail/Air			0.1	0.1			0.5	0.5			1.2
FUGITIVE DUST:											
Railroad yards	37.8 ac		6.7	6.9			3.7	3.7			21.0
Clean streets	$22X10^6$VMT	13.6	4.5	9.4	9.2	0.7	9.6	16.3	11.4	3.3	78.0
Unpaved rds/alleys	$27X10^3$VMT		24.4	0.1	0.1		37.2	16.9	1.6	1.5	81.8
Cleared areas	90.8 ac	0.7	2.8	4.2	0.9	0.9	11.6	13.1	1.9	2.3	38.4
Construction	6.5 ac						58.5		23.4	70.3	152.2
Agriculture	310 ac						12.3	15.4	9.8	44.6	82.1
Storage areas	5.5 ac						0.4		0.1		0.5
Unpaved pkg lots	$63X10^3$VMT	0.1	0.8	1.2	0.1	0.2	4.4	0.9	0.3	0.8	8.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.5	4.6	19.4	25.5
FUGITIVE DUST	14.4	73.1	375.3	462.8
Total	15.9	77.7	394.7	488.3

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Church Barchard Murphy Gin	35.2	22.9	4.6	3	637.2	3642.4
2	Growers Brawley Gin	90.9	59.1	4.0	2	643.9	3649.7
3	Planter's Cotton Gin	72.9	47.4	4.9	4	633.0	3656.3
4	Imperial Irrigation District	0.5	0.5	0.3	3	637.1	3649.7

DESCRIPTION OF SITE (Number 9)

SAROAD code - 051295001

Location - Tower Road, N. of China Lake, CA

UTM coordinates - 442.2 3951.8

Monitor height - 6 feet

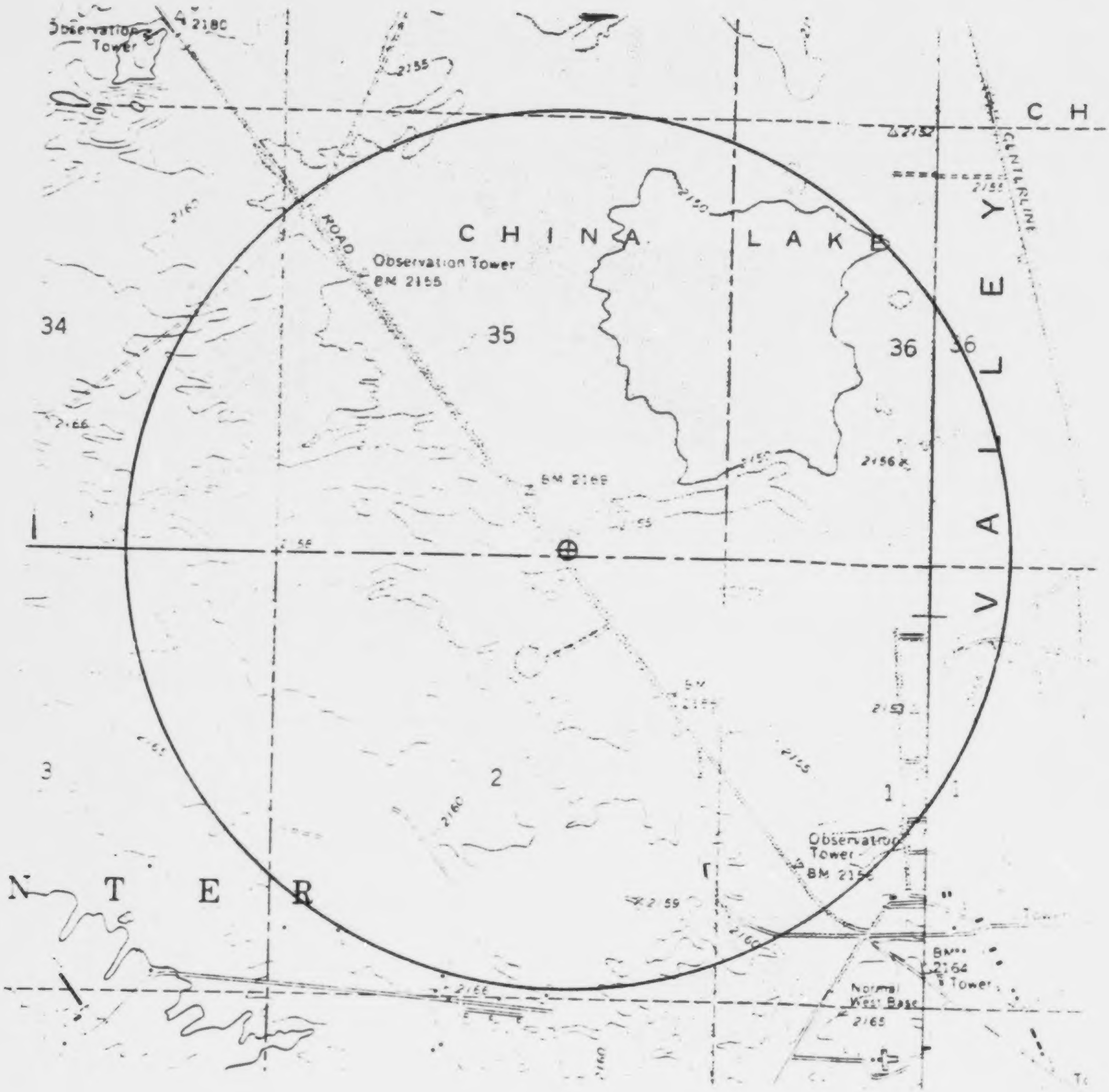
Topography - dry lake bed

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Tower Road	120 feet	Paved, 100 ADT
Exposed ground	Completely surrounding monitor	Dry lake bed; no vegetation

Air quality data -

Monitor	Year	Annual arithmetic mean, μg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
I01	1982	25.6	0	0	52	0	0
I01	1983	29.0	0	0	31	0	0


Observation Tower
2180
2155
C H
2152
2155
CENTERLINE
2160
ROAD
C H I N A L A K E
Observation Tower
BM 2155
2150
34
35
36
36
V A L L E Y
2166
BM 2168
2155
2150
2156
3
2
1
1
2160
2155
BM 2155
2150
Observation Tower
BM 2155
N T E R
2159
2160
2166
BM 2164
Tower
Normal West Base
2165
2160

One mile radius around China Lake. (Site 9)

AREA SOURCE SUMMARY (Site 9)

Site: China Lake

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators											
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$73X10^3$VMT	0.1		0.1			0.1		0.1	0.1	0.5
Unpaved rds/alleys											
Cleared areas	402 ac	20.7	15.7	15.7	15.7	15.7	62.7	62.7	62.7	62.7	334.3
Construction.											
Agriculture											
Storage areas											
Unpaved pkg lots											

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION				
FUGITIVE DUST	20.8	62.9	251.1	334.8
Total	20.8	62.9	251.1	334.8

AREA SOURCE SUMMARY (Site 9)

Site: China Lake

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators											
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$73X10^3$VMT	0.1		0.1			0.1		0.1	0.1	0.5
Unpaved rds/alleys											
Cleared areas	402 ac	10.6	8.0	8.0	8.0	8.0	31.9	31.9	31.9	31.9	170.2
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots											

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION				
FUGITIVE DUST	10.7	32.1	127.9	170.7
Total	10.7	32.1	127.9	170.7

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Naval Weapons Center	8.0	7.4	4.0	3	441.6	3945.4

DESCRIPTION OF SITE (Number 10)

SAROAD code - 052240001

Location - 935 Broadway, El Centro, CA

UTM coordinates - 634.6 3629.1

Monitor height - 25 feet

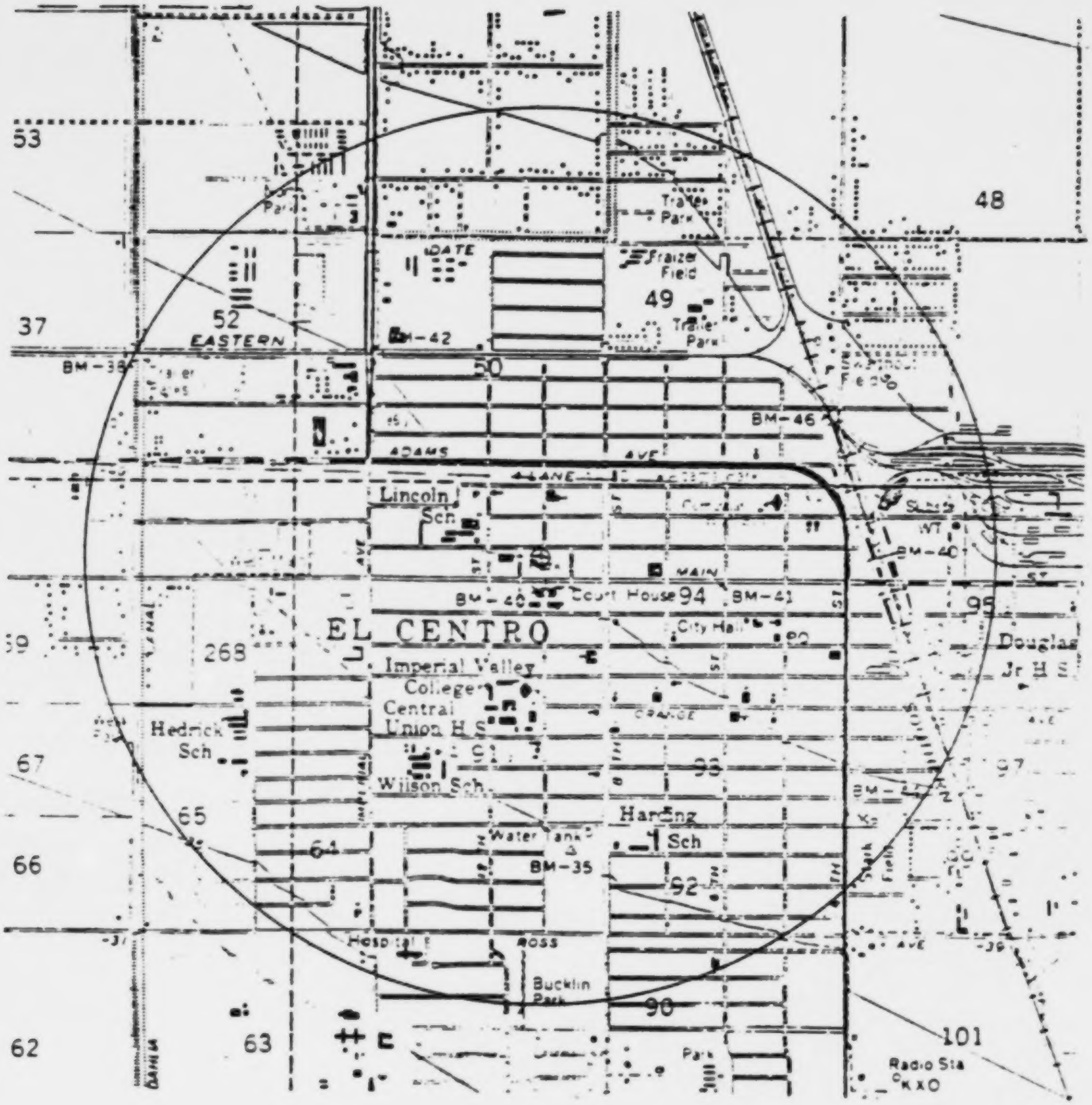
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Broadway Avenue	115 feet	Paved, 2500 ADT
9th Street	195 feet	Paved, 1000 ADT
Main Street	200 feet	Paved, 9140 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
I01	1982	122.6	0	0	42	0	0
I01	1983	88.0	0	0	19	0	0


53
48
37
52
EASTERN
BM-42
49
Fraizer Field
Trailer Park
50
BM-46
ADAMS
AVE
Lincoln Sch
MAIN
BM-40
Court House
94
BM-41
City Hall
95
EL CENTRO
Douglas Jr H S
268
Imperial Valley College
Central Union H S
Hedrick Sch
67
91
93
97
Wilson Sch
65
Harding Sch
Water Tank
BM-35
66
64
92
Hospital
ROSS
Bucklin Park
90
62
63
101
Radio Sta KXO

One mile radius around 935 Broadway, El Centro, California. (Site 10)

AREA SOURCE SUMMARY (Site 10)

Site: El Centro

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.8	0.6	0.6	0.6	0.6	2.4	2.4	2.4	2.4	12.8
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.3
Incinerators		1.1	0.8	0.8	0.8	0.8	3.3	3.3	3.3	3.3	17.5
Rail/Air							0.6	0.3			0.9
FUGITIVE DUST:											
Railroad yards	49 ac						36.0	17.4			53.4
Clean streets	59X10^{6}VMT	37.8	27.5	24.5	27.6	27.3	35.3	90.4	39.7	45.8	355.9
Unpaved rds/alleys	37X10^{3}VMT	1.4	6.3	4.9	0.9	4.6	6.7	23.3	9.2	13.1	70.4
Cleared areas	299 ac	9.1	5.5		19.2	14.6	118.7	23.7	16.4	41.0	248.2
Construction											
Agriculture	6 ac							5.5			5.5
Storage areas											
Unpaved pkg lots	19X10^{3}VMT	0.7	0.1	0.7	0.1	0.2	1.1	0.9	0.2	0.7	4.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	2.0	6.0	24.5	32.5
FUGITIVE DUST	49.0	164.0	525.1	738.1
Total	51.0	170.0	549.6	770.6

AREA SOURCE SUMMARY (Site 10)

Site: El Centro

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.6	0.4	0.4	0.4	0.4	1.8	1.8	1.8	1.8	9.4
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	1.3
Incinerators		0.8	0.6	0.6	0.6	0.6	2.5	2.5	2.5	2.5	13.2
Rail/Air											
FUGITIVE DUST:											
Railroad yards	49 ac						18.4	8.9			27.3
Clean streets	$59X10^6$VMT	22.3	16.2	14.4	16.3	16.1	20.8	53.3	23.4	27.0	209.8
Unpaved rds/alleys	$37X10^3$VMT	0.8	3.5	2.7	0.5	2.6	3.8	13.0	5.2	7.3	39.4
Cleared areas	299 ac	4.6	2.8		9.8	7.4	60.5	12.1	8.4	20.9	126.5
Construction											
Agriculture	6 ac										
Storage areas								2.6			2.6
Unpaved pkg lots	$19X10^3$VMT	0.4	0.1	0.4	0.1	0.1	0.6	0.5	0.1	0.4	2.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.5	4.4	18.0	23.9
FUGITIVE DUST	28.1	93.0	287.2	408.3
Total	29.6	97.4	305.2	432.2

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Imperial Cotton Producers	24.1	15.7	4.3	3	629.5	3624.5
2	Imperial Irrigation District	174.0	160.8	2.0	2	637.7	3628.0
3	Ryerson Concrete Co.	32.5	16.2	1.2	1, 2	636.5	3629.1
4	United Alfalfa Mills	19.5	9.3	1.1	1	636.4	3629.4
5	Valley Nitrogen	135.2	90.0	1.1	1	636.3	3629.7
6	Massey Sand and Rock	179.8	89.9	1.6	1	637.1	3629.7
7	R. T. Pinner and Sons	4.0	2.0	1.2	1, 2	636.5	3629.1

DESCRIPTION OF SITE (Number 11)

SAROAD code - 052680001

Location - 14838 Foothill Blvd., Fontana, CA

UTM coordinates - 455.8 3773.1

Monitor height - monitor no longer in place

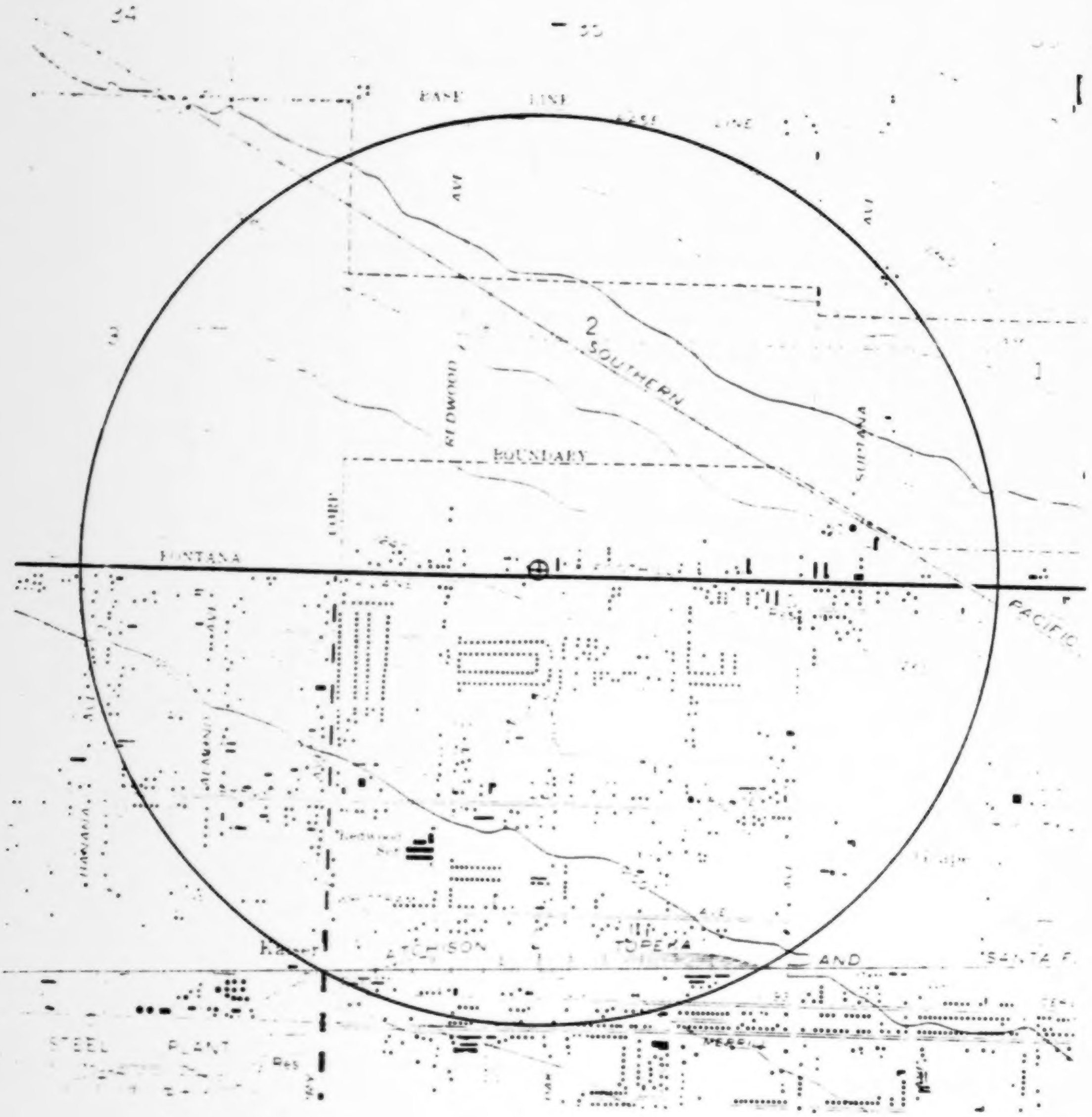
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Foothill Blvd.	117 feet	Paved, 13000 ADT
Unnamed road	72 feet	Unpaved
Unnamed road	72 feet	Unpaved

Air quality data -

Monitor	Year	Annual arithmetic mean, $\mu g/m^3$ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
I01	1980	129.3	0	0	51	0	0
I01	1981	142.9	0	0	56	0	0


BASE LINE
AVE
2
SOUTHERN
PACIFIC
3
1
REDWOOD
BOUNDARY
SULTANA
FONTANA
ATCHISON
TOPEKA
AND
SANTA FE
Kaiser
STEEL PLANT

One mile radius around 14838 Foothill Blvd., Fontana. (Site 11)

AREA SOURCE SUMMARY (Site 11)

Site: Fontana

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2		0.2	0.2			0.4	0.7		1.7
Comm/Ind fuel		0.3		0.2	0.2			0.4	0.7		1.8
Incinerators								0.2	0.1		0.3
Rail/Air											
FUGITIVE DUST:											
Railroad yards	19 ac							1.7	1.0		2.7
Clean streets	17X10^{6}VMT	14.9		8.5	10.7		2.0	31.9	36.5		104.5
Unpaved rds/alleys	27X10^{3}VMT	1.2		1.9			12.0	13.7	15.6	0.4	44.8
Cleared areas	27 ac	0.3		0.3	0.1			1.6	0.6		2.9
Construction											
Agriculture	212 ac	30.7	54.6	10.9		30.1	10.2	4.1	4.1		144.7
Storage areas	25 ac							0.6	0.8		1.4
Unpaved pkg lots	5X10^{3}VMT			0.1			0.9	0.1	0.1		1.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.5	0.8	2.5	3.8
FUGITIVE DUST	47.1	117.2	137.9	302.2
Total	47.6	118.0	140.4	306.0

AREA SOURCE SUMMARY (Site 11)

Site: Fontana

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2		0.2	0.2			0.3	0.5		1.4
Comm/Ind fuel											
Incinerators		0.2		0.2	0.2			0.3	0.5		1.4
Rail/Air								0.2	0.1		0.3
FUGITIVE DUST:											
Railroad yards	19 ac							0.9	0.5		1.4
Clean streets	$17X10^6$VMT	8.8		5.0	6.3		1.2	18.8	21.5		61.6
Unpaved rds/alleys	$27X10^3$VMT	0.7		1.1			6.7	7.7	8.7	0.2	25.1
Cleared areas	27 ac	0.2		0.2	0.1			0.8	0.3		1.6
Construction											
Agriculture	212 ac	13.7	24.6	4.9		13.5	4.6	1.8	1.8		64.9
Storage areas	25 ac							0.3	0.4		0.7
Unpaved pkg lots	$5X10^3$VMT			0.1			0.5	0.1	0.1		0.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.4	0.8	1.9	3.1
FUGITIVE DUST	23.4	55.8	76.9	156.1
Total	23.8	56.6	78.8	159.2

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Kaiser Steel	2940.0	2739.1	1.7	3	454.0	3771.6
2	S. C. Edison Co.	470.0	433.5	3.0	3	450.8	3773.2
3	Ameron Steel	4.0	3.9	3.0	3	450.8	3773.2
4	National Can	2.0	2.0	3.0	3	450.8	3773.2
5	Vista Metals	2.0	2.0	2.0	3	452.4	3773.2
6	Rockwool Industries	33.0	25.7	2.4	3	452.4	3771.6
7	Supracote Inc.	1.0	1.0	5.0	3	447.6	3773.2
8	AT&SF Kaiser Steel Railyard	0.5	0.5	1.5	3	454.0	3772.0
9	General Latex and Chemical	4.2	4.1	5.0	3	447.6	3773.2
10	SOC-CO Plastic Coating Co.	0.1	0.1	5.0	3	447.6	3773.2
11	Southern California Finishing Inc.	5.5	5.4	5.0	3	447.6	3773.2
12	G & N Bronze	1.1	1.0	4.0	3	449.2	3773.2
13	Brookside Vineyard	0.1	0.1	4.0	3	449.2	3773.2
14	Tamco	93.8	86.3	4.0	3	449.2	3773.2
15	Schlosser Forge Co.	2.9	2.7	4.0	3	449.2	3773.2
16	Pacific Forge	1.6	1.5	3.8	3	450.8	3770.0
17	Johnson-Bateman Company	0.6	0.6	3.8	3	450.8	3770.0
18	Plexco	2.4	2.4	3.8	3	450.8	3770.0
19	Chino Grain and Milling	19.4	12.6	3.8	3	450.8	3770.0

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
20	Union Carbide, Linde Division	0.2	0.2	3.8	3	450.8	3770.0
21	Ameron-Price Co.	6.8	3.4	3.8	3	450.8	3770.0
22	Ferromet	0.8	0.7	3.0	3	450.8	3773.2
23	Ameron Pipe Products	14.3	7.2	3.0	3	450.8	3773.2
24	Fontana Paper Mills Corp.	0.8	0.8	3.2	3	452.4	3769.9
25	Pacific Corrugated Pipe	2.8	2.6	3.2	3	452.4	3769.9
26	Kaiser Steel, Fabricated Products	10.1	9.3	2.5	3	452.4	3771.5
27	Heckett Division	28.1	14.0	2.5	3	452.4	3773.2
28	Black Products	3.0	1.5	2.5	3	452.4	3773.2
29	Nordix	0.2	0.1	2.7	3	454.0	3769.2
30	Pelletech	7.5	3.8	1.8	3	454.0	3771.5
31	E. L. Yeger Construction	7.8	3.9	1.8	3	454.0	3771.5
32	Koppers Co., Inc.	0.3	0.3	1.1	3	454.0	3773.2
33	General Concrete	0.8	0.4	1.1	3	454.0	3773.2
34	Controlled Coatings Corp.	0.9	0.9	3.4	3	455.6	3768.3
35	Hillyard Aluminum Recovery	3.3	2.7	3.4	3	455.6	3768.3
36	Swift Agricultural Chemicals Corp.	5.4	5.3	2.4	3	455.6	3769.9
37	Fontana Paving	28.0	15.9	1.3	2	457.3	3772.7
38	D & D Rubber	0.1	0.1	3.6	2	457.2	3768.3

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
39	Anchor Roof Tiles, Inc.	1.0	0.5	3.2	1	458.8	3778.0
40	Burton Sand Blast	0.3	0.3	5.0	2	463.6	3773.1

DESCRIPTION OF SITE (Number 12)

SAROAD code - 055330231

Location - 3021 Manor Street, Oil Dale, CA

UTM coordinates - 408.1 3921.6

Monitor height - monitor has been removed

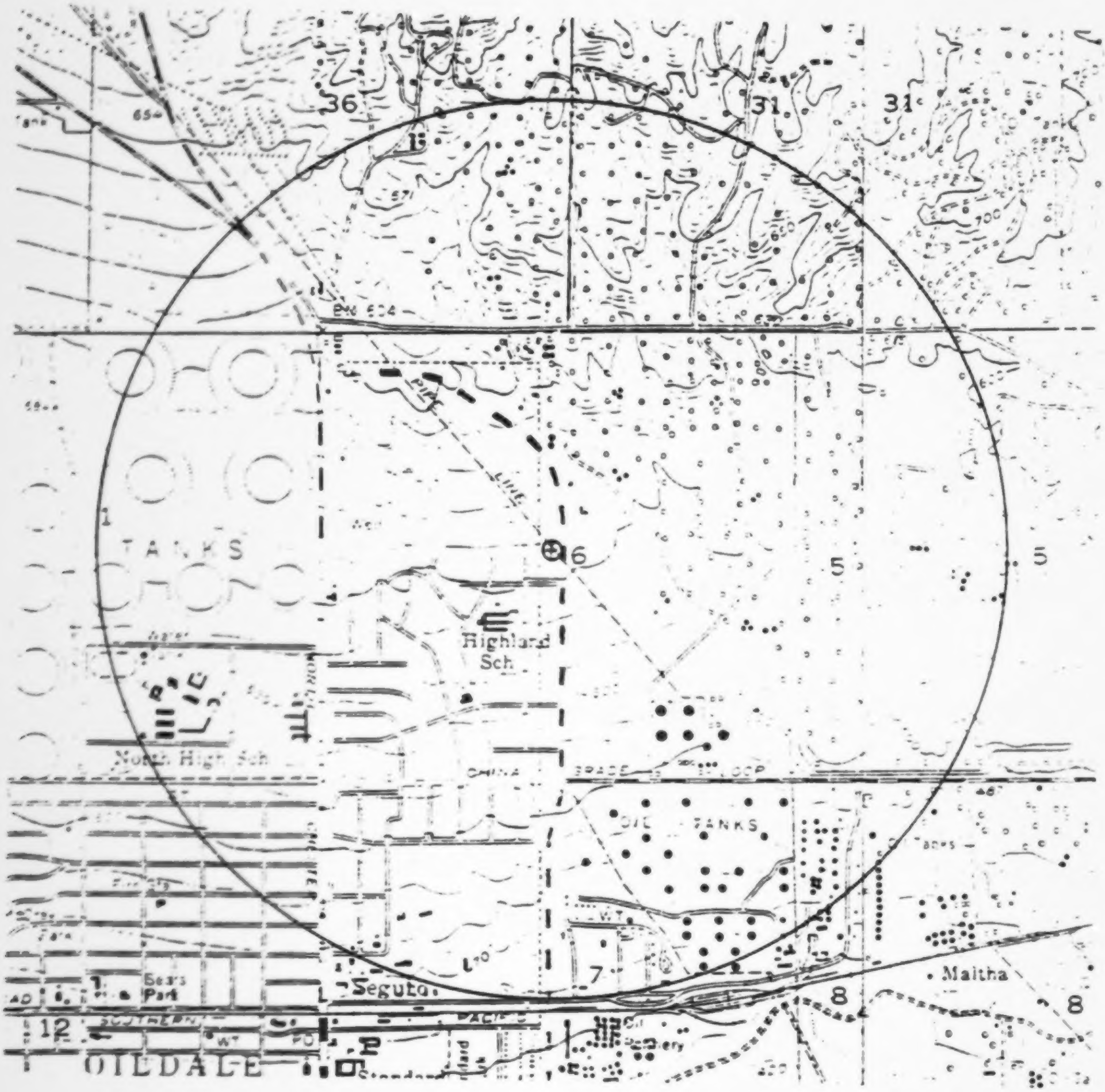
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Manor Street	111 feet	Paved, 8000 ADT
Alley	125 feet	Paved, 25 ADT
Alley	20 feet	Unpaved

Air quality data -

Monitor	Year	Annual arithmetic mean, μg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
F01	1982	107	0	0	99	0	0
F01	1983	108	0	0	49	0	0


36
31
31
BM 624
TANKS
1
6
5
5
Highland Sch
North High Sch
CHINA GRADE LOOP
OIL TANKS
Bears Park
Seguro
7
8
8
Maltha
12
SOUTHERN PACIFIC
OILDALE

One mile radius around 3021 Manor Street, Oil Dale. (Site 12)

AREA SOURCE SUMMARY (Site 12)

Site: Oildale

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2		0.1	0.2	0.2			0.7		1.4
Comm/Ind fuel									0.1		0.1
Incinerators		0.5		0.1	0.4	0.4			1.4		2.8
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$15X10^6$VMT	9.2		4.5	1.6	1.4		22.3	34.9	13.3	87.2
Unpaved rds/alleys	$105X10^3$VMT	11.2	22.8	17.2		3.4	90.7	2.6	2.6	20.7	171.2
Cleared areas	668 ac	0.3	4.2	2.6			17.0	17.0	2.1	17.0	60.2
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	$11X10^3$VMT						0.2	11.6		2.4	14.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.7	1.4	2.2	4.3
FUGITIVE DUST	20.7	57.7	254.4	332.8
Total	21.4	59.1	256.6	337.1

AREA SOURCE SUMMARY (Site 12)

Site: Oildale

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2		0.1	0.2	0.2			0.5		1.2
Comm/Ind fuel									0.1		0.1
Incinerators		0.4		0.1	0.3	0.3			1.0		2.1
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$15X10^6$VMT	5.4		2.7	0.9	0.8		13.2	20.6	7.8	51.4
Unpaved rds/alleys	$105X10^3$VMT	6.3	12.8	9.6		1.9	50.8	1.5	1.5	11.6	96.0
Cleared areas	668 ac	0.2	2.1	1.3			8.7	8.7	1.2	8.7	30.9
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	$11X10^3$VMT						0.1	6.5		1.3	7.9

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.6	1.2	1.6	3.4
FUGITIVE DUST	11.9	32.1	142.2	186.2
Total	12.5	33.3	143.8	189.6

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	IMC Corp.	38.3	37.5	4.4	3	313.4	3916.8
2	DICCO Inc.	54.0	27.0	4.3	3	316.6	3916.0
3	DICCO Inc.	44.0	22.0	3.5	4	313.0	3926.6
4	Pacific Foundries	9.0	8.3	4.2	3	314.8	3916.6
5	San Joaquin Refining	40.0	36.8	3.2	3	314.3	3918.7
6	Tosco Corp.	163.4	161.6	3.1	3	314.2	3918.8
7	West Coast Oil Co.	43.2	40.0	1.2	2	318.7	3921.5
8	Continental Grain	38.0	24.7	4.5	4	310.2	3924.2
9	Mobil Chemical	4.0	2.0	2.5	3	313.5	3921.3
10	Getty Oil, Eastside Oil Prod.	1368.2	1258.7	1.1	2	319.0	3922.8
11	Chevron USA Inc., Oil Dale	845.8	779.8	3.2	2	322.4	3922.7
12	Tenneco Oil Co.	199.8	183.8	0.2	1	317.5	3922.7
13	Texaco Oil Co.	3.4	3.2	3.2	4	315.3	3927.6
14	Standard Oil, Kern Pump Station	11.4	10.5	3.1	4	312.2	3923.0
15	Shell Oil, Bakersfield Pump Station	2.7	2.5	1.9	4	314.6	3924.2
16	Huntmix Inc.	59.0	29.5	5.0	2	325.3	3922.8
17	Shell Oil, Norris Road	845.5	778.0	3.4	1	320.0	3927.6
18	DICCO, Inc.	18.0	9.0	3.1	4	313.2	3925.7
19	Chaparral Oil	4.5	4.1	1.9	2	320.2	3921.8
20	Road Oil Sales, Inc.	8.7	8.0	3.0	2	321.7	3920.8

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
21	Sabre Refining Inc.	10.9	10.6	3.5	3	314.0	3918.3
22	Chevron USA, Inc. Bakersfield	4.8	4.5	1.0	2	318.3	3921.5
23	Golden Bear Refinery	51.8	47.7	1.0	2	317.4	3921.2
24	B & R Oil Co.	0.1	0.1	2.7	3	316.5	3918.5
25	Carrec Oil	0.4	0.4	5.0	1	317.8	3930.9
26	Consolidated Fiberglass	41.0	37.7	3.3	3	314.2	3918.4
27	C. D. Drauker	0.2	0.2	1.3	4	315.5	3924.0
28	Union Oil, Kern Pump Station	0.1	0.1	0.3	1	317.5	3923.3
29	Gibson Oil and Refining Co.	0.2	0.2	4.5	3	313.3	3916.8

DESCRIPTION OF SITE (Number 13)

SAROAD code - 056535001

Location - 5888 Mission Blvd., Rubidoux, CA

UTM coordinates - 461.8 3762.2

Monitor height - 7 feet

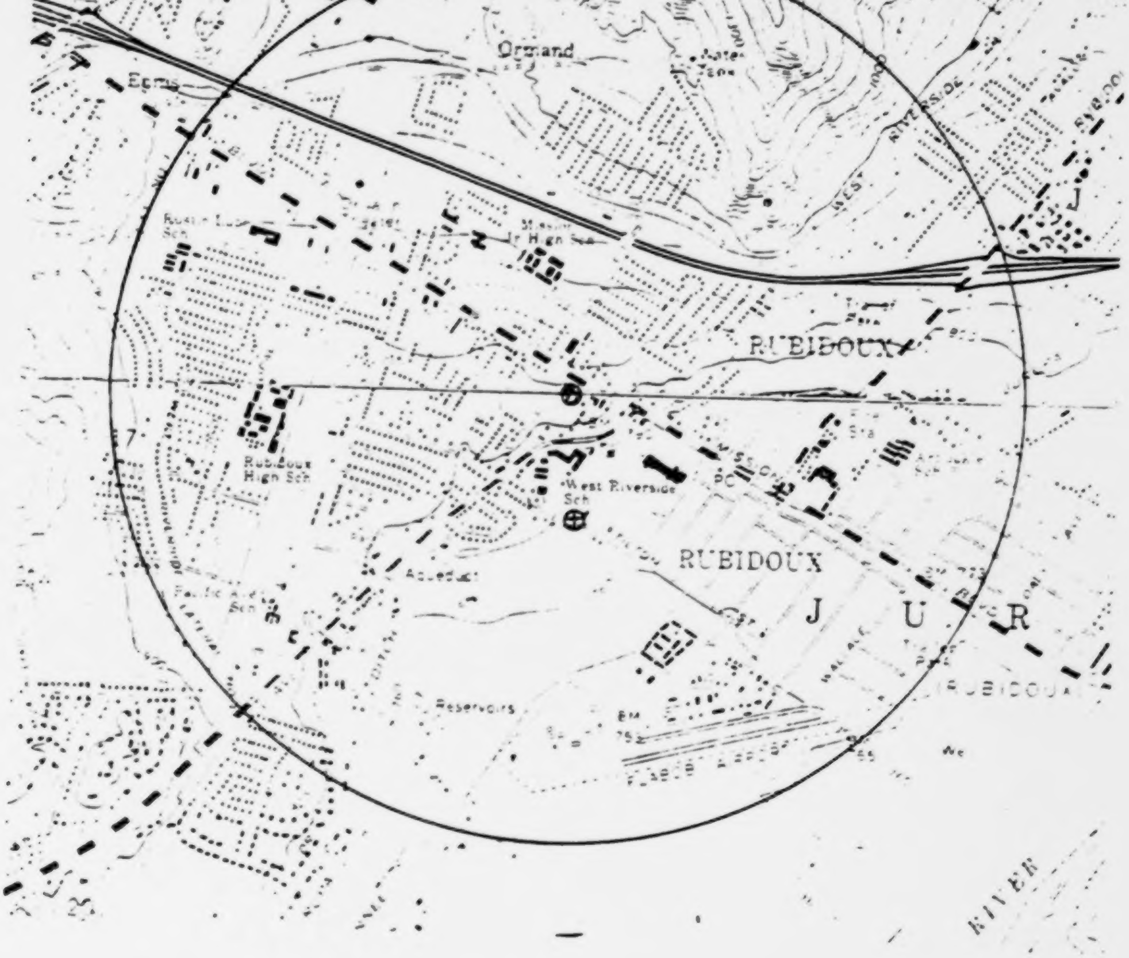
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Parking lot	Adjacent	Paved

Air quality data -

Monitor	Year	Annual arithmetic mean, $\mu g/m^3$			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
I01	1982	117.8	0	0	50	0	0
I01	1983	146.9	0	0	32	0	0
A07	1980	160.8	87.5	0	56	35	0
A07	1981	126.7	107.7	0	8	28	0
A07	1982	130.4	92.4	78.4	45	38	36


Sunnyslope
Industrial Waste Ponds
Well
Ormand
Water Tank
West Riverside
Rubidoux High Sch
RUBIDOUX
Mission
West Riverside Sch
RUBIDOUX
J U R
Aqueduct
Reservoirs
RUBIDOUX
RIVER

One mile radius around 5888 Mission Blvd., Rubidoux. (Site 13)

AREA SOURCE SUMMARY (Site 13)

Site: 5888 Mission Blvd.

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.8	0.6	0.6	0.6	0.6	2.5	2.5	2.5	2.5	13.2
Comm/Ind fuel							0.2	0.2	0.2	0.2	0.8
Incinerators		0.8	0.6	0.6	0.6	0.6	2.5	2.5	2.5	2.5	13.2
Rail/Air								1.0			1.0
FUGITIVE DUST:											
Railroad yards											
Clean streets	49X10^{6}VMT	23.1	48.0	16.1	11.4	9.9	68.5	23.9	18.4	76.0	295.3
Unpaved rds/alleys	31X10^{3}VMT	1.9	10.0	1.2		1.2	19.9	13.1	4.4	0.6	52.3
Cleared areas	33 ac	0.2	0.1	1.6			0.8	0.6		0.2	3.5
Construction	3.2 ac					7.4	16.2				23.6
Agriculture	5 ac		1.7					1.7			3.4
Storage areas	19 ac									1.0	1.0
Unpaved pkg lots	21X10^{3}VMT					0.4			0.8	3.8	5.0

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.6	4.8	21.8	28.2
FUGITIVE DUST	25.2	109.0	249.9	384.1
Total	26.8	113.8	271.7	412.3

AREA SOURCE SUMMARY (Site 13)

Site: 5888 Mission Blvd.

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.6	0.4	0.4	0.4	0.4	1.9	1.9	1.9	1.9	9.8
Comm/Ind fuel							0.2	0.2	0.2	0.2	0.8
Incinerators		0.6	0.4	0.4	0.4	0.4	1.9	1.9	1.9	1.9	9.8
Rail/Air								1.0			1.0
FUGITIVE DUST:											
Railroad yards											..
Clean streets	$49X10^6$VMT	13.6	28.3	9.4	6.7	5.8	40.4	14.1	10.9	44.8	174.0
Unpaved rds/alleys	$31X10^3$VMT	1.1	5.6	0.7		0.7	11.1	7.3	2.5	0.3	29.3
Cleared areas	33 ac	0.1	0.1	0.8			0.4	0.3		0.1	1.8
Construction	3.2 ac					3.8	8.3				12.1
Agriculture	5 ac		0.8					0.8			1.6
Storage areas	19 ac									0.5	0.5
Unpaved pkg lots	$21X10^3$VMT					0.2			0.4	2.1	2.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.2	3.2	17.0	21.4
FUGITIVE DUST	14.8	62.9	144.3	222.0
Total	16.0	66.1	161.3	243.4

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	California Edison	1.0	1.0	1.9	3	458.7	3761.8
2	SPTC West Colton Railyard	23.7	23.2	4.7	1	465.0	3769.0
3	D & D Rubber	0.1	0.1	4.8	4	457.2	3768.3
4	Southwestern Bandag, Inc.	0.1	0.1	4.9	1	463.6	3769.8
5	Matich Corp.	0.8	0.8	3.5	1	465.2	3766.6
6	Holiday Trucking, Inc.	8.5	8.3	4.3	1	465.2	3768.2
7	Owl Rock Products	4.2	2.8	4.8	1	466.7	3768.2
8	Alumax Mill, Inc.	68.0	55.7	4.1	1	468.3	3763.3
9	Riverside Cement	249.3	124.6	2.7	1	465.1	3765.0
10	Luxfer U.S.A., Ltd.	1.0	1.0	4.3	2	468.3	3760.1
11	AT & SF Riverside Railyard	2.3	2.2	3.5	2	467.0	3760.0
12	Standard Ready-Mix Concrete	0.8	0.4	4.9	4	453.9	3763.4
13	Calpro Company	0.4	0.4	4.9	4	453.9	3763.4
14	Van's Rock and Sand Inc.	12.0	6.0	4.1	3	455.5	3760.3
15	Orco Block Company	2.5	1.2	3.9	4	455.6	3763.4
16	Rohr Industries, Inc.	6.0	5.9	3.7	3	458.7	3757.0
17	Robertson Ready Mix	6.6	3.3	3.7	3	458.7	3757.0
18	Lasagna, Inc.	0.1	0.1	3.7	3	458.7	3757.0
19	Flexsteel Industries, Inc.	0.2	0.2	3.7	3	458.7	3757.0
20	City of Riverside	20.0	10.0	2.9	3	458.7	3758.6

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
21	U.S. Pipe and Foundry	2.8	1.4	2.3	3	458.7	3760.2
22	Paul Hubbs Construction Company	5.0	2.5	2.6	4	458.7	3765.1
23	Riverside Unified School District	0.5	0.4	4.4	3	460.3	3755.3
24	Jefferson Elementary School	0.8	0.6	4.3	2	461.9	3755.3
25	Riverside Unified School District	1.2	0.9	4.3	2	461.9	3755.3
26	Riverside Unified School District	0.9	0.7	3.3	2	461.9	3756.9
27	Texas Mining Company	11.4	5.7	1.4	1	463.6	3763.4
28	Rome Tire Service	1.9	1.9	2.4	2	465.1	3760.2
29	Evergreen Cemetary	0.6	0.4	2.4	2	465.1	3760.2
30	Riverside Monumental	0.1	0.1	2.4	2	465.1	3760.2
31	Riverside Community Hospital	3.9	3.8	2.4	2	465.1	3760.2
32	Sand Blasting Service Company	0.2	0.2	2.2	1	465.1	3763.3
33	Certain-Teed Co.	1.4	1.4	2.7	1	465.1	3765.0
34	E. L. Yeager Construction Co.	1.6	0.8	2.7	1	465.1	3765.0
35	Dealer Tire Sales	0.1	0.1	3.8	2	466.7	3758.5
36	Riverside Fertilizer Works	0.9	0.4	3.3	2	466.7	3760.1
37	Poultrymen's Cooperative Assoc.	0.6	0.6	3.3	2	466.7	3760.1
38	Polytechnic High School	1.2	0.9	3.3	2	466.7	3760.1

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
39	ECO Engineering, Inc.	0.2	0.2	3.3	2	466.7	3760.1
40	L & M Frame and Axle Shop, Inc.	0.3	0.3	3.3	2	466.7	3760.1
41	Riverside County Dept. of Buildings and Grounds	0.3	0.3	3.3	2	466.7	3760.1
42	E. R. Carpenter Company, Inc.	2.0	2.0	3.3	2	466.7	3760.1
43	Riverside Unified School District	1.2	0.9	4.3	2	468.3	3760.1
44	Alpase, Inc.	0.7	0.7	4.3	2	468.3	3760.1
45	Poultrymen's Cooperative Assoc.	18.5	18.1	4.1	2	468.3	3761.7
46	Devoe and Reynolds	0.5	0.5	4.1	2	468.3	3761.7
47	Owl Rock Products	0.9	0.4	4.1	2	468.3	3761.7
48	Conrock Company	26.0	13.0	4.1	2	468.3	3761.7

DESCRIPTION OF SITE (Number 14)

SAROAD code - 320090001

Location - Cobre Consolidated School Supply, near corner of North East and
Mayo Streets, Bayard, NM

UTM coordinates - 768.8 3628.1

Monitor height - 12 ft., on instrument platform

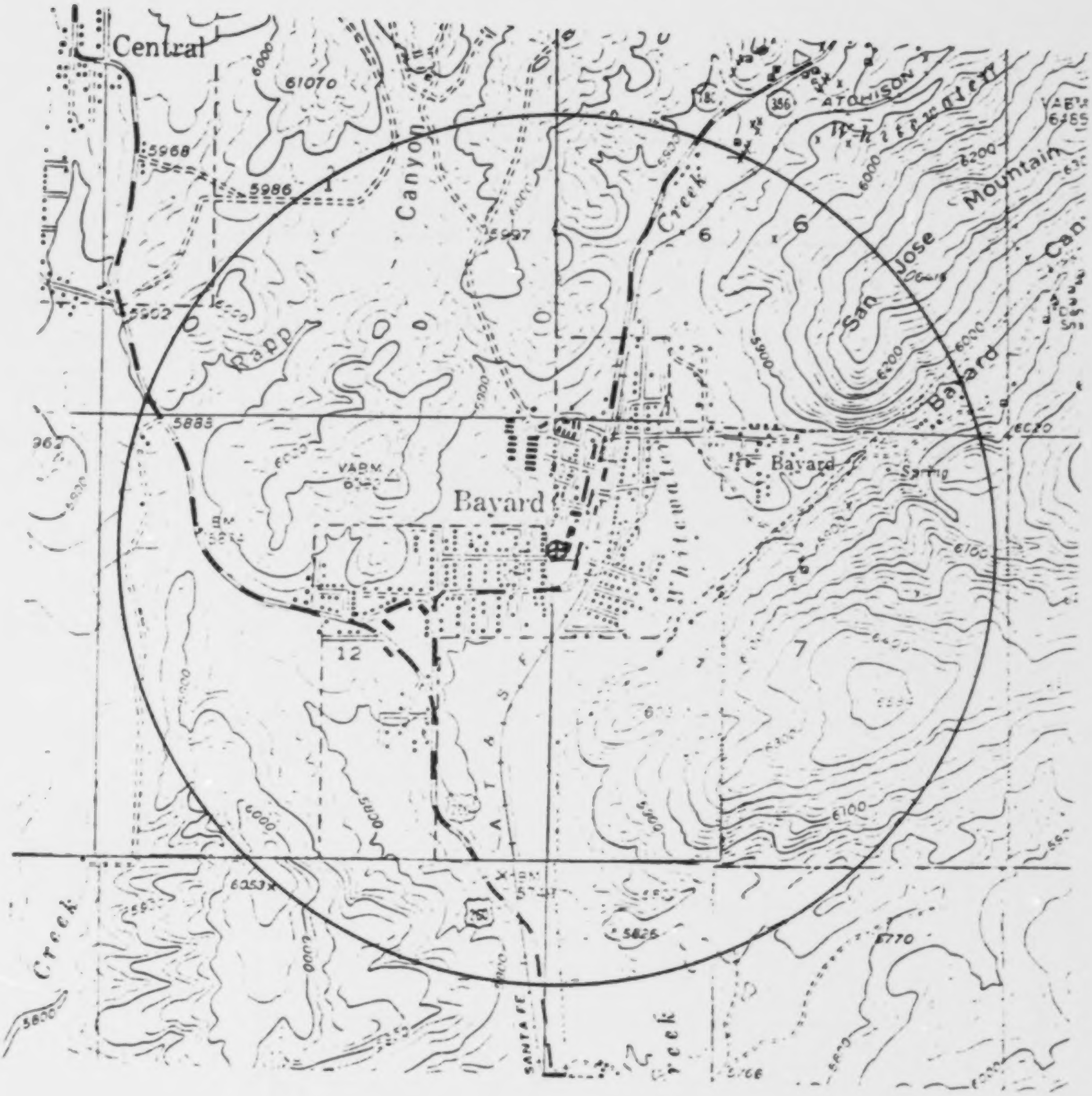
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
North East Street	106 feet	Paved, 100 ADT
Mayo Street	28 feet	Paved, 1000 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, $\mu g/m^3$ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
F01	1982	132.2	0	0	57	0	0
F01	1983	115.8	0	0	60	0	0
A07	1980	142.0	82.0	0	4	3	0
A07	1981	122.0	89.0	0	55	52	0
A07	1982	110.0	72.1	0	48	37	0



Central
Canyon
Rapp
Bayard
Bayard
Creek
Whitewater
San Jose
Mountain
Bayard Can
ATCHISON
SANTA FE
Creek
12
6
6
7
7
5968
5986
5997
5883
6070
6000
6200
6100
6400
5825
5770
5800
6053

One mile radius around Cobre Supply, Bayard. (Site 14)

AREA SOURCE SUMMARY (Site 14)

Site: Bayard

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		1.2	0.6		0.6						
Comm/Ind fuel											2.4
Incinerators		2.4	1.2		1.2						
Rail/Air		0.4	0.2		0.2		0.4		0.4		4.8
FUGITIVE DUST:											1.6
Railroad yards	7 ac	7.8	5.2				2.6	2.6			18.2
Clean streets	14X10^{6}VMT	13.6	3.4		17.8		6.6		34.0	11.2	86.6
Unpaved rds/alleys	74X10^{3}VMT	27.9	20.2		11.1	6.3	23.3		9.6	23.3	121.7
Cleared areas	12 ac	7.2	3.6	3.6			3.6	7.2	10.8	7.2	43.2
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	2X10^3 VMT	0.5							0.1		0.6

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	4.0	4.0	0.8	8.8
FUGITIVE DUST	57.0	71.2	142.1	270.3
Total	61.0	75.2	142.9	279.1

AREA SOURCE SUMMARY (Site 14)

Site: Bayard

Source category	Activity rate	PM$_{10}$ Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel		0.9	0.4		0.4						1.7
Incinerators											
Rail/Air		1.8	0.9		0.9						3.6
FUGITIVE DUST:		0.4	0.2		0.2		0.4		0.4		1.6
Railroad yards	7 ac	4.0	2.7				1.3	1.3			9.3
Clean streets	14X10^{6}VMT	8.0	2.0		10.5		3.9		20.1	6.6	51.1
Unpaved rds/alleys	74X10^{3}VMT	15.6	11.3		6.2	3.5	13.0		5.4	13.0	68.0
Cleared areas	12 ac	3.7	1.8	1.8			1.8	3.7	5.5	3.7	22.0
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	2X10^3 VMT	0.3							0.1		0.4

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	3.1	3.0	0.8	6.9
FUGITIVE DUST	31.6	39.8	79.4	150.8
Total	34.7	42.8	80.2	157.7

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
	NONE						

DESCRIPTION OF SITE (Number 15)

SAROAD code - 320240001

Location - Anthony Elementary School, Anthony, NM

UTM coordinates - 348.7 3541.8

Monitor height - 15 ft., on roof of building

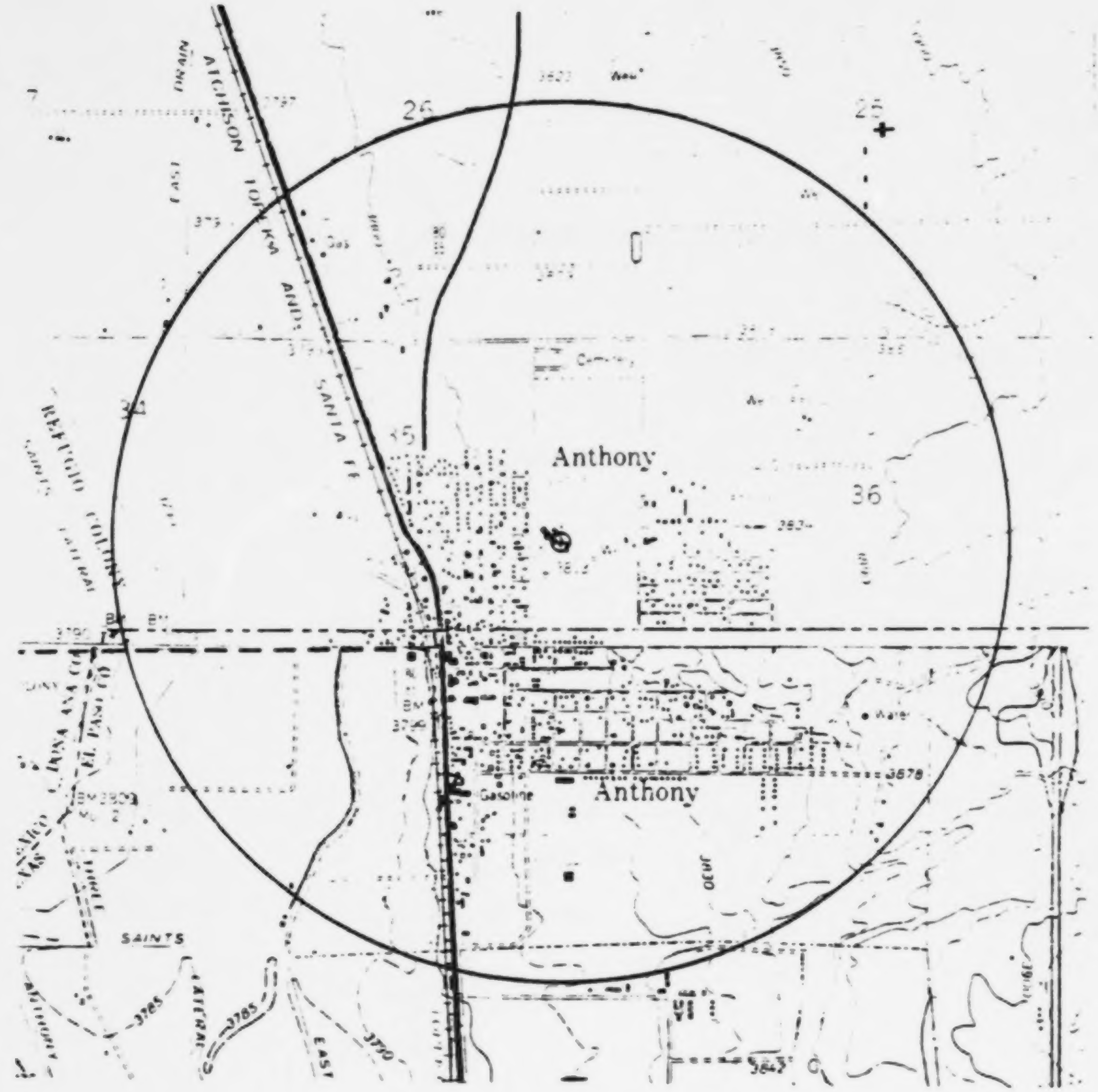
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Incinerator	90 feet	Small garbage incinerator
Playground	Adjacent	Unpaved

Air quality data -

Monitor	Year	Annual arithmetic mean, $\mu g/m^3$ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
F02	1982	130.8	0	0	57	0	0
F02	1983	115.6	0	0	60	0	0


ATCHISON TOPEKA AND SANTA FE
EAST DRAIN
26
25
35
36
34
Cemetery
Anthony
Anthony
Gasoline
DONA ANA CO
EL PASO CO
SAINTS
LATERAL
EAST
3878
3785
3765
3790
BM 3809

One mile radius around Anthony School, Dona Ana County. (Site 15)

AREA SOURCE SUMMARY (Site 15)

Site: Anthony School

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.2	0.2	0.2	0.2	0.6	0.6	0.6	0.6	3.4
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.4	0.4	2.1
Incinerators											
Rail/Air					0.1	0.1			0.2	0.2	0.6
FUGITIVE DUST:											
Railroad yards	49 ac				36.4	15.6			39.0	36.4	127.4
Clean streets	$4X10^6$VMT	2.6	2.0	1.7	4.0	3.0	0.4	2.0	5.4	5.6	26.7
Unpaved rds/alleys	$66X10^3$VMT	7.3	4.7	10.0	2.4	0.9	20.6	23.2	21.2	21.7	112.0
Cleared areas	382 ac	19.9	36.1		8.1	65.0	323.1	491.0	101.1	153.4	1197.7
Construction											
Agriculture	496 ac				48.3	40.6			417.0	451.7	957.6
Storage areas											
Unpaved pkg lots	$18X10^3$VMT	1.3			0.2			0.8	1.9		4.2

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.3	1.4	4.4	6.1
FUGITIVE DUST	31.1	279.0	2115.5	2425.6
Total	31.4	280.4	2119.9	2431.7

AREA SOURCE SUMMARY (Site 15)

Site: Anthony School

Source category	Activity rate	PM$_{10}$ Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	2.6
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.4	0.4	2.1
Incinerators											
Rail/Air					0.1	0.1			0.2	0.2	0.6
FUGITIVE DUST:											
Railroad yards	49 ac				18.6	8.0			20.0	18.6	65.2
Clean streets	4X10^{6}VMT	1.5	1.2	1.0	2.4	1.8	0.2	1.2	3.2	3.3	15.8
Unpaved rds/alleys	66X10^{3}VMT	4.1	2.6	5.6	1.3	0.5	11.5	13.0	11.9	12.2	62.7
Cleared areas	382 ac	10.1	18.4		4.1	33.2	164.8	250.4	51.6	78.2	610.8
Construction											
Agriculture	496 ac										
Storage areas					24.0	20.1			206.8	224.0	474.9
Unpaved pkg lots	18X10^{3}VMT	0.7			0.1			0.4	1.1		2.3

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.3	1.4	3.6	5.3
FUGITIVE DUST	16.4	142.9	1072.4	1231.7
Total	16.7	144.3	1076.0	1237.0

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
	NONE						

DESCRIPTION OF SITE (Number 16)

SAROAD code - 320440001

Location - Grant County Water Dept. Bldg., near corner of A and First Streets,
Hurley, NM

UTM coordinates - 769.5 3621.4

Monitor height - 12 ft., on roof of building

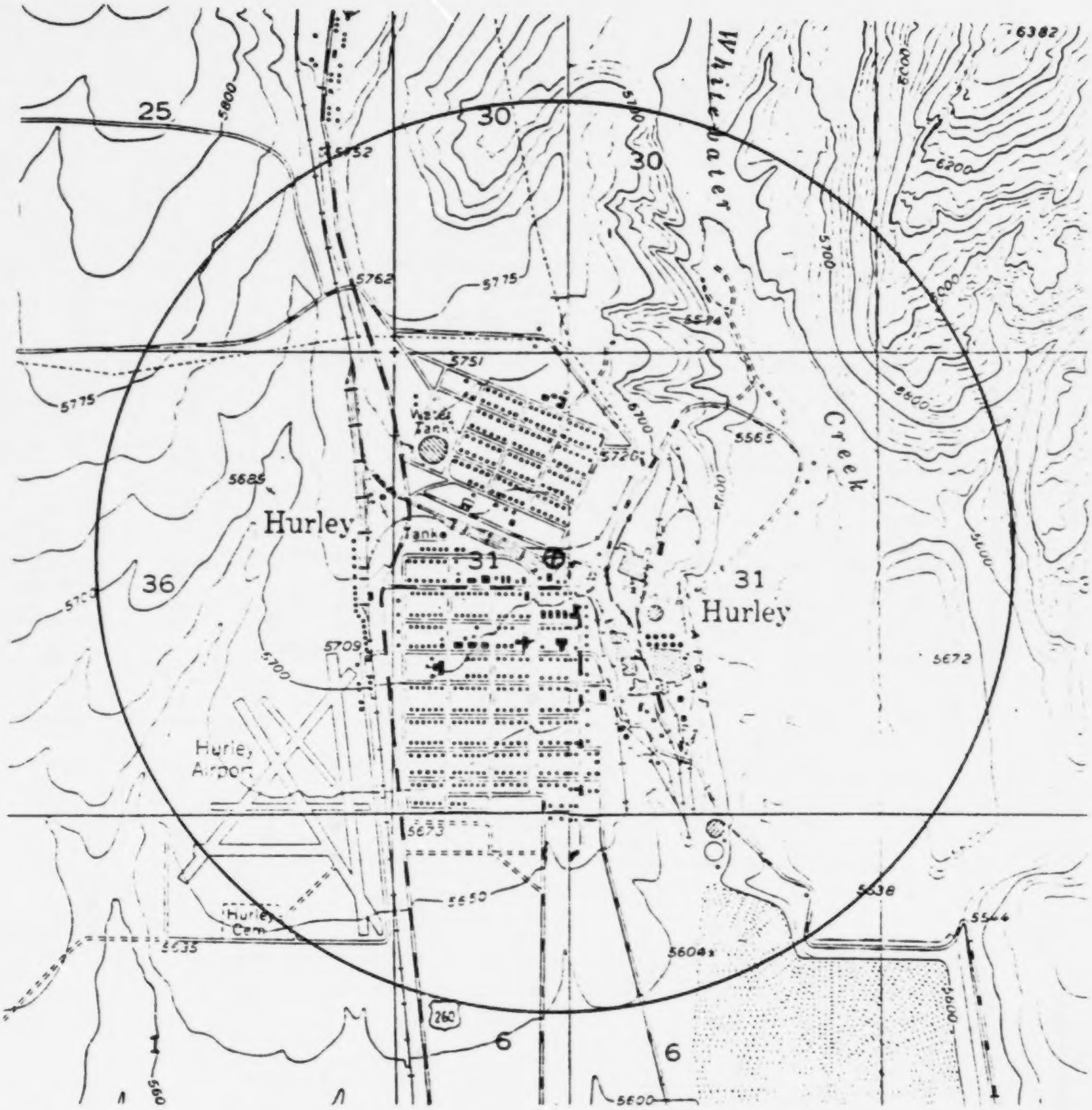
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Unnamed street	24 feet	Unpaved

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
F02	1982	111.5	0	0	57	0	0
F02	1983	98.1	0	0	59	0	0


25
30
30
White Water Creek
6382
5800
5752
6200
5762
5775
5700
6000
5574
5775
5751
Water Tank
5720
5565
5685
Hurley
Tanks
31
31
Hurley
36
5700
5709
5672
Hurley Airport
5673
5638
5650
Hurley Cem
5635
5604
5544
5600
260
6
6
1
5600

One mile radius around Grant County, Hurley. (Site 16)

AREA SOURCE SUMMARY (Site 16)

Site: Hurley

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.3	0.1	0.1	0.2	0.2			0.1	0.1	1.1
Comm/Ind fuel											
Incinerators		0.6	0.2	0.2	0.5	0.5			0.2	0.2	2.4
Rail/Air		0.5			0.2	0.6				0.2	1.5
FUGITIVE DUST:											
Railroad yards	17 ac	15.6			5.2	18.2				5.2	44.2
Clean streets	5X10^{6}VMT	1.5	0.1	0.6	3.6	2.5			11.5	10.5	30.3
Unpaved rds/alleys	196X10^{3}VMT	58.8	37.7	16.8	2.5	6.3	278.8	333.2	15.6	12.6	762.3
Cleared areas	92 ac	7.2	36.1	54.2	7.2	14.4	72.2	108.3	18.0	14.4	332.0
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	16X10^{3}VMT	3.3			0.1	0.4					3.8

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.4	2.8	0.8	5.0
FUGITIVE DUST	86.4	205.9	880.3	1172.6
Total	87.8	208.7	881.1	1177.6

AREA SOURCE SUMMARY (Site 16)

Site: Hurley

Source category	Activity rate	PM$_{10}$ Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.1	0.1	0.2	0.2			0.1	0.1	1.0
Comm/Ind fuel											
Incinerators		0.4	0.2	0.2	0.4	0.4			0.2	0.2	2.0
Rail/Air		0.4			0.2	0.4				0.2	1.2
FUGITIVE DUST:											
Railroad yards	17 ac	8.0			2.7	9.3				2.7	22.7
Clean streets	5X10^{6}VMT	0.9	0.1	0.4	2.1	1.5			6.8	6.2	18.0
Unpaved rds/alleys	196X10^{3}VMT	32.9	21.1	9.4	1.4	3.5	156.1	186.6	8.7	7.1	426.8
Cleared areas	92 ac	3.7	18.4	27.6	3.7	7.3	36.8	55.2	9.2	7.3	169.2
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots	16X10^{3}VMT	1.8			0.1	0.2					2.1

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	1.0	2.4	0.8	4.2
FUGITIVE DUST	47.3	108.8	482.7	638.8
Total	48.3	132.8	483.5	643.0

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Kennecott Copper, Hurley Smelter	2306	2122	0.1	2	769.7	3621.3

DESCRIPTION OF SITE (Number 17)

SAROAD code - 451700002

Location - Tillman Health Center, 222 South Campbell Street, El Paso, TX

UTM coordinates - 359.8 3514.4

Monitor height - 35 ft., on roof of building

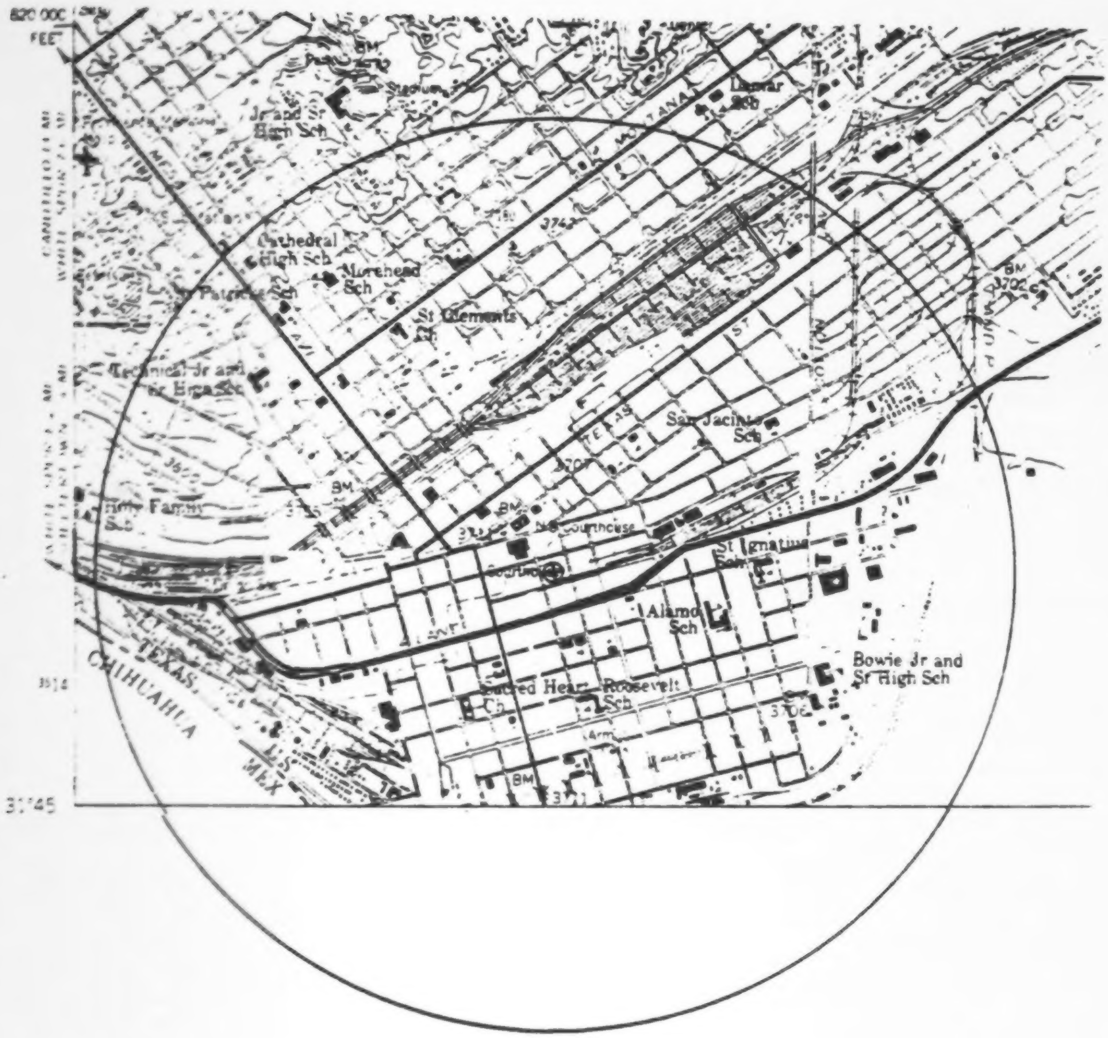
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Florence Street	144 feet	Paved, 2065 ADT
First Avenue	84 feet	Paved, 2065 ADT
Campbell Street	120 feet	Paved, 9710 ADT
Parking lot	Adjacent	Paved, adjacent to east, west, and south sides of building

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
F01	1982	99.2	0	0	52	0	0
F01	1983	95.5	0	0	51	0	0
A07	1980	125.3	73.2	0	43	27	0
A07	1981	115.7	60.1	0	20	52	0
A07	1982	164.9	94.7	0	4	5	0


820 000 FEET
Jr and Sr High Sch
Stadium
MONTANA
Lamar Sch
3743
Cathedral High Sch
Morehead Sch
St Patricks Sch
St Clements Ch
BM 3702
Technical Jr and Sr High Sch
TEXAS
San Jacinto Sch
Holy Family Sch
BM
Courthouse
St Ignatius Sch
Alamo Sch
Bowie Jr and Sr High Sch
Sacred Heart Ch
Roosevelt Sch
3706
TEXAS
CHIHUAHUA
MEX
BM
31°45

One mile radius around Tillman Health Center, 222 S. Campbell Street, El Paso. (Site 17)

AREA SOURCE SUMMARY (Site 17)

Site: Tillman Health Center

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel						0.1	0.2		0.1	0.3	0.7
Comm/Ind fuel		0.1									0.1
Incinerators		0.5	0.3	0.3	0.3	0.3	1.4	1.4	1.4	1.4	7.3
Rail/Air			0.4			0.4	1.6		0.7	0.1	3.2
FUGITIVE DUST:											
Railroad yards	105 ac	2.6	36.4			36.4	127.4		59.8	10.4	273.0
Clean streets	123X10^{6}VMT	62.9	25.0	15.5	36.8	57.8	219.3	38.5	61.4	220.7	737.9
Unpaved rds/alleys	65X10^{3}VMT		15.3			20.6	30.6		32.3	12.0	110.8
Cleared areas											
Construction	5.5 ac	40.8			51.0	20.4					112.2
Agriculture											
Storage areas	9 ac						7.2	0.9			8.1
Unpaved pkg lots	30X10^{3}VMT	0.2	1.2		0.9	0.2	3.2		1.2		6.9

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.6	2.1	8.6	11.3
FUGITIVE DUST	106.5	317.5	824.9	1248.9
Total	107.1	319.6	833.5	1260.2

AREA SOURCE SUMMARY (Site 17)

Site: Tillman Health Center

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel						0.1	0.2		0.1	0.2	0.6
Comm/Ind fuel		0.1									0.1
Incinerators		0.4	0.2	0.2	0.2	0.2	1.0	1.0	1.0	1.0	5.2
Rail/Air			0.3			0.3	1.2		0.5	0.1	2.4
FUGITIVE DUST:											
Railroad yards	105 ac	1.3	18.6			18.6	65.0		30.5	5.3	139.3
Clean streets	123X10^{6}VMT	37.1	14.8	9.1	21.7	34.1	76.3	22.7	36.2	130.2	382.2
Unpaved rds/alleys	65X10^{3}VMT		8.6			11.5	17.1		18.1	6.7	62.0
Cleared areas											
Construction	5.5 ac	20.8			26.0	10.4					57.2
Agriculture											
Storage areas	9 ac						3.7	0.5			4.2
Unpaved pkg lots	30X10^{3}VMT	0.1	0.7		0.5	0.1	1.8		0.7		3.9

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.5	1.5	6.3	8.3
FUGITIVE DUST	59.3	174.7	414.8	648.8
Total	59.8	176.2	421.1	657.1

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	ASARCO, Inc.	327.1	300.9	3.0	4	355.8	3517.0
2	Border Steel Mills, Inc.	42.7	38.0	2.1	4	356.4	3514.4
3	El Paso Rock Quarries, Inc.	259.0	129.5	3.2	1	360.2	3519.6
4	Parker Brothers and Company Inc.	260.1	130.0	3.1	4	355.8	3517.5
5	Southwestern Portland Cement Co.	479.3	407.4	3.5	4	355.6	3518.1
6	Texaco, Inc.	483.6	473.9	4.7	1	367.3	3515.4

DESCRIPTION OF SITE (Number 18)

SAROAD code - 451700031

Location - 2616 W. Paisano, El Paso, TX

UTM coordinates - 355.3 3517.3

Monitor height - 10 feet

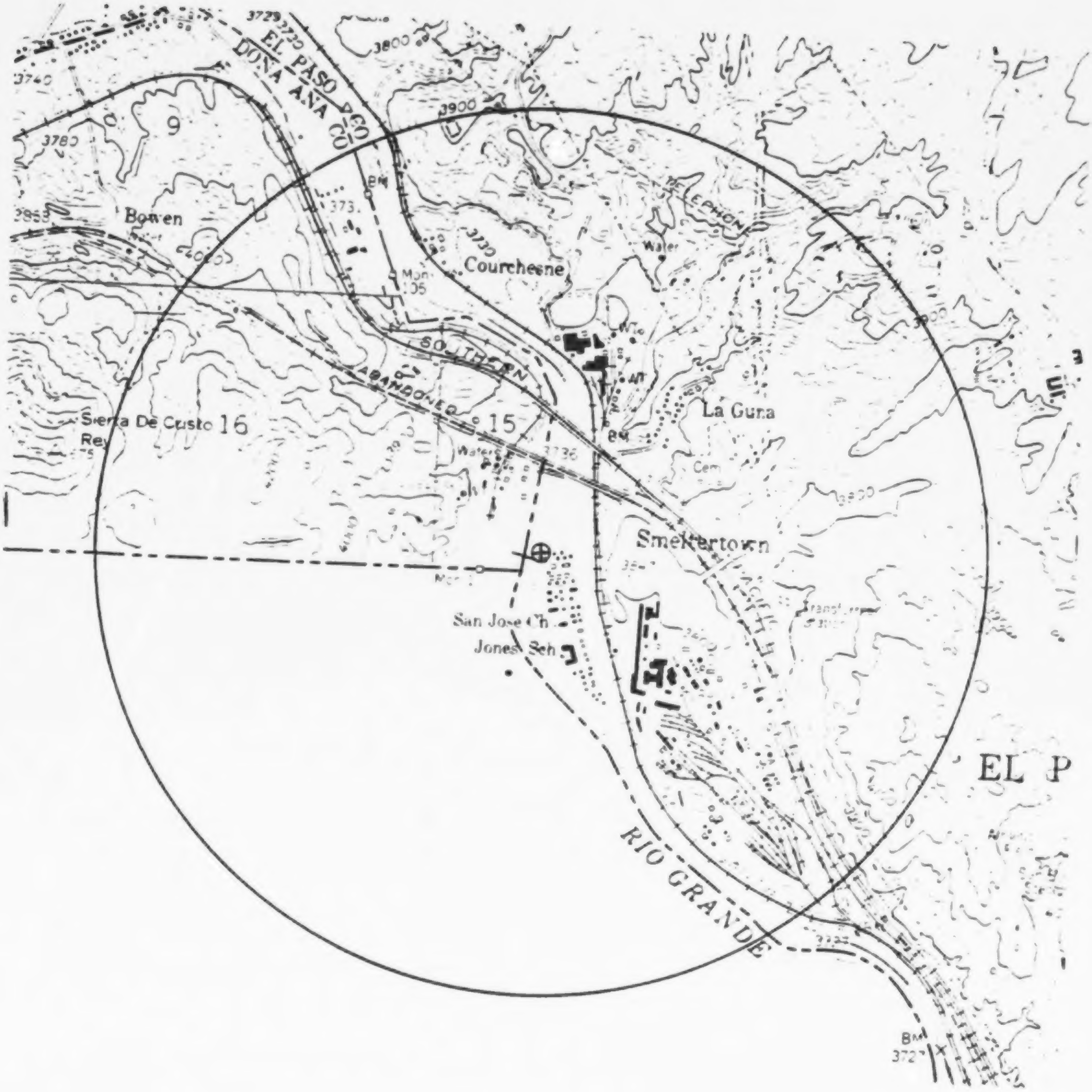
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Unpaved Road	Adjacent	Adjacent to east side of monitor

Air quality data -

Monitor	Year	Annual arithmetic mean, μg/m³ TSP	IP	PM_{10}	No. of samples TSP	IP	PM_{10}
G02	1982	169.9	0	0	56	0	0
G02	1983	139.2	0	0	57	0	0


EL PASO CO
DONA ANA CO
9
Bowen
Courchesne
SOUTHERN
ABANDONED
Sierra De Cristo Rey
16
15
La Guna
Cem
Smeltertown
San Jose Ch
Jones Sch
RIO GRANDE
EL P
3800
3900
3780
3740
Water
BM
3736

One mile radius around 2616 W. Paisano, El Paso. (Site 18)

AREA SOURCE SUMMARY (Site 18)

Site: 2616 West Paisano

Source category	Activity rate	TSP Emissions by sector, ton/yr 1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators											
Rail/Air		0.2	0.2			0.1	0.1	0.5		0.2	1.3
FUGITIVE DUST:											
Railroad yards	134 ac	28.6	28.6	10.4		20.8	5.2	182.0		72.8	348.4
Clean streets	$31X10^6$VMT	12.2	17.7	6.3		2.2	36.1	95.8		15.2	185.5
Unpaved rds/alleys	$99X10^3$VMT	11.8	11.2	5.9		14.1	37.6	41.1		47.0	168.7
Cleared areas	197 ac	83.0	68.6	90.2			72.2	108.3		288.8	711.1
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots											

Recap	Emissions by sector, t/yr 1	2-5	6-9	Total
COMBUSTION	0.2	0.3	0.8	1.3
FUGITIVE DUST	135.6	276.0	1002.1	1413.7
Total	135.8	276.3	1002.9	1415.0

AREA SOURCE SUMMARY (Site 18)

Site: 2616 West Paisano

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel											
Comm/Ind fuel											
Incinerators											
Rail/Air		0.2	0.2			0.1	0.1	0.5		0.2	1.3
FUGITIVE DUST:											
Railroad yards	134 ac	14.6	14.6	5.3		10.6	2.7	92.8		37.1	177.7
Clean streets	$31X10^6$VMT	7.2	10.4	3.7		1.3	21.3	56.5		9.0	109.4
Unpaved rds/alleys	$99X10^3$VMT	6.6	6.3	3.3		7.9	21.1	23.0		26.3	94.5
Cleared areas	197 ac	42.3	35.0	46.0			36.8	55.2		147.3	362.6
Construction											
Agriculture											
Storage areas											
Unpaved pkg lots											

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.2	0.3	0.8	1.3
FUGITIVE DUST	70.7	144.4	529.1	744.2
Total	70.9	144.7	529.9	745.5

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	ASARCO, Inc.	327.1	300.9	0.4	2	355.8	3517.0
2	Border Steel Mills, Inc.	42.7	38.0	1.9	2	356.4	3514.4
3	El Paso Rock Quarries, Inc.	259.0	129.5	3.4	1	360.2	3519.6
4	Parker Brothers and Company Inc.	260.1	130.0	0.3	1	355.8	3517.5
5	Southwestern Portland Cement Co.	479.3	407.4	0.5	1	355.6	3518.1
6	El Paso Electric Co., Rio Grande Station	26.0	26.0	1.8	4	353.4	3519.6

DESCRIPTION OF SITE (Number 19)

SAROAD code - 451710004

Location - Clint High School, Highway 20, Clint, TX

UTM coordinates - 383.4 3495.3

Monitor height - monitor no longer located at site

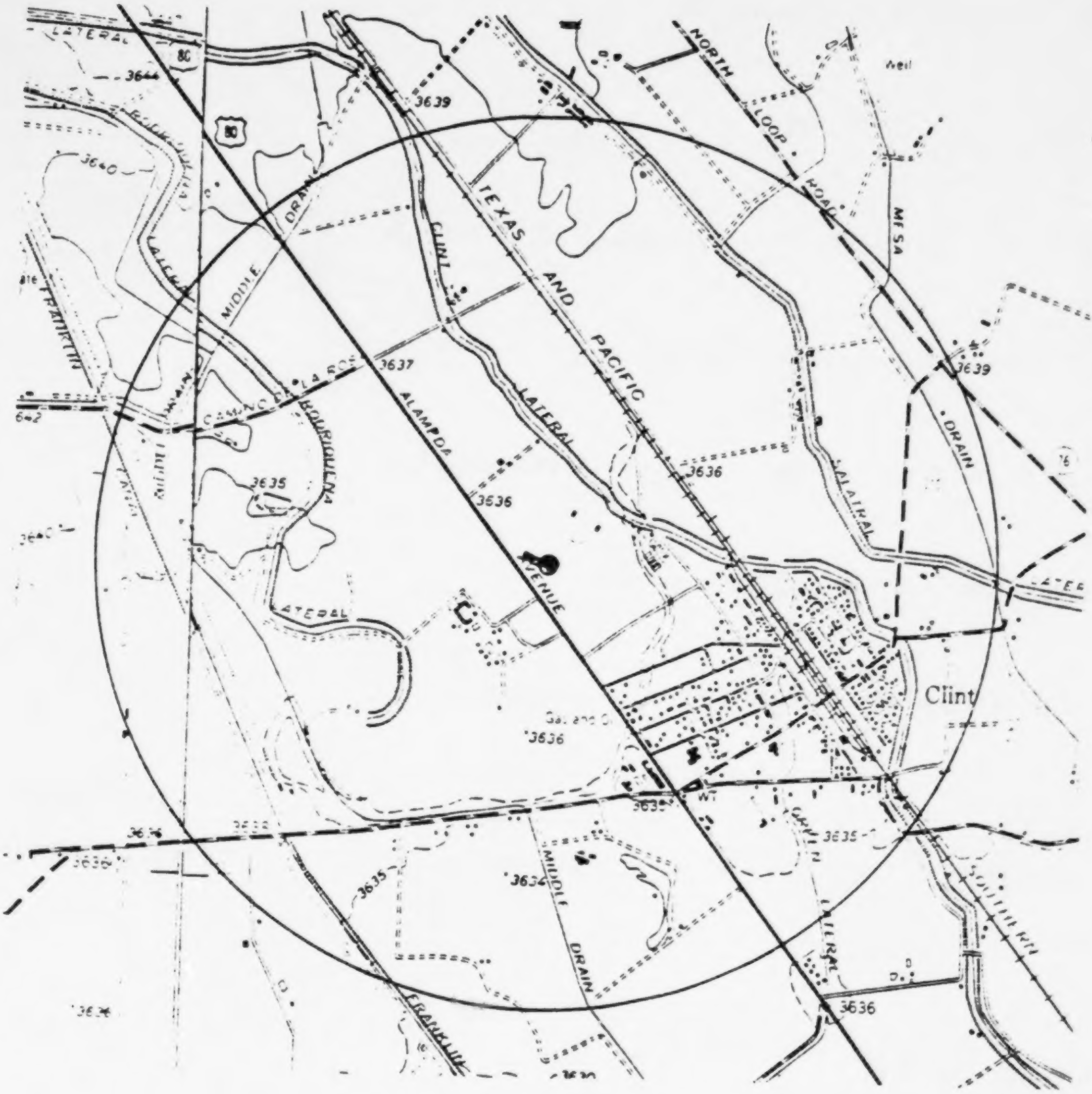
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Highway 20	Unknown	Paved, 3100 ADT

Air quality data -

Monitor	Year	Annual arithmetic mean, µg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
A07	1980	91.4	57.0	0	43	41	0
A07	1981	67.0	46.1	0	50	53	0
A07	1982	89.0	52.8	0	41	33	0


LATERAL
80
3644
3639
3640
Well
NORTH
LOOP
ROAD
MESA
TEXAS
AND
PACIFIC
CLINT
LATERAL
MIDDLE
DRAIN
CAMINO DE LA ROSA
3637
ALAMEDA
AVENUE
3636
3635
3639
DRAIN
LATERAL
Clint
3636
3635
3634
MIDDLE
DRAIN
3635
3636
FRANKLIN
SOUTHERN
3636
642

One mile radius around Clint, TX, Clint High School. (Site 19)

AREA SOURCE SUMMARY (Site 19)

Site: Clint

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel								0.1			0.1
Comm/Ind fuel											
Incinerators		0.1		0.2	0.1			0.6	0.1	0.1	1.2
Rail/Air			0.2					0.2		0.2	0.6
FUGITIVE DUST:											
Railroad yards	24 ac		26.0	5.2				23.4		7.8	62.4
Clean streets	4X10^{6}VMT	3.4	0.5	2.5		1.8	2.6	4.3	1.8	4.9	21.8
Unpaved rds/alleys	38X10^{3}VMT	7.6	9.4	2.1	3.2		11.2		9.7	22.0	65.2
Cleared areas	13 ac	7.2		25.3					14.4		46.9
Construction											
Agriculture	1043 ac	94.6	96.5		38.6	67.4	134.2	181.4	393.8	454.6	1461.1
Storage areas	14 ac			7.2				0.9	4.5		12.6
Unpaved pkg lots	29X10^{3}VMT			1.3				5.2	0.1		6.6

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.1	0.5	1.3	1.9
FUGITIVE DUST	112.8	287.0	1276.8	1676.6
Total	112.9	287.5	1278.1	1678.5

AREA SOURCE SUMMARY (Site 19)

Site:

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel								0.1			0.1
Comm/Ind fuel											
Incinerators		0.1		0.2	0.1			0.4	0.1	0.1	1.0
Rail/Air			0.2					0.2		0.2	0.6
FUGITIVE DUST:											
Railroad yards	24 ac		13.3	2.7				11.9		4.0	31.9
Clean streets	4X10^{6}VMT	2.0	0.3	1.5		1.1	1.5	2.5	1.1	2.9	12.9
Unpaved rds/alleys	38X10^{3}VMT	4.3	5.3	1.2	1.8		6.3		5.4	12.3	36.6
Cleared areas	13 ac	3.7		12.9					7.3		23.9
Construction											
Agriculture	1043 ac	46.9	48.0		19.1	32.8	60.6	90.0	195.2	224.0	716.6
Storage areas	14 ac			3.7				0.5	2.3		6.5
Unpaved pkg lots	29X10^{3}VMT			0.7				2.9	0.1		3.7

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.1	0.5	1.1	1.7
FUGITIVE DUST	56.9	144.4	630.8	832.1
Total	57.0	144.9	631.9	833.8

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
	NONE						

DESCRIPTION OF SITE (Number 20)

SAROAD code - 060520001

Location - 2935 South, 8560 West, Magna, Utah

UTM coordinates - 407.6 4506.6

Monitor height - 25 feet

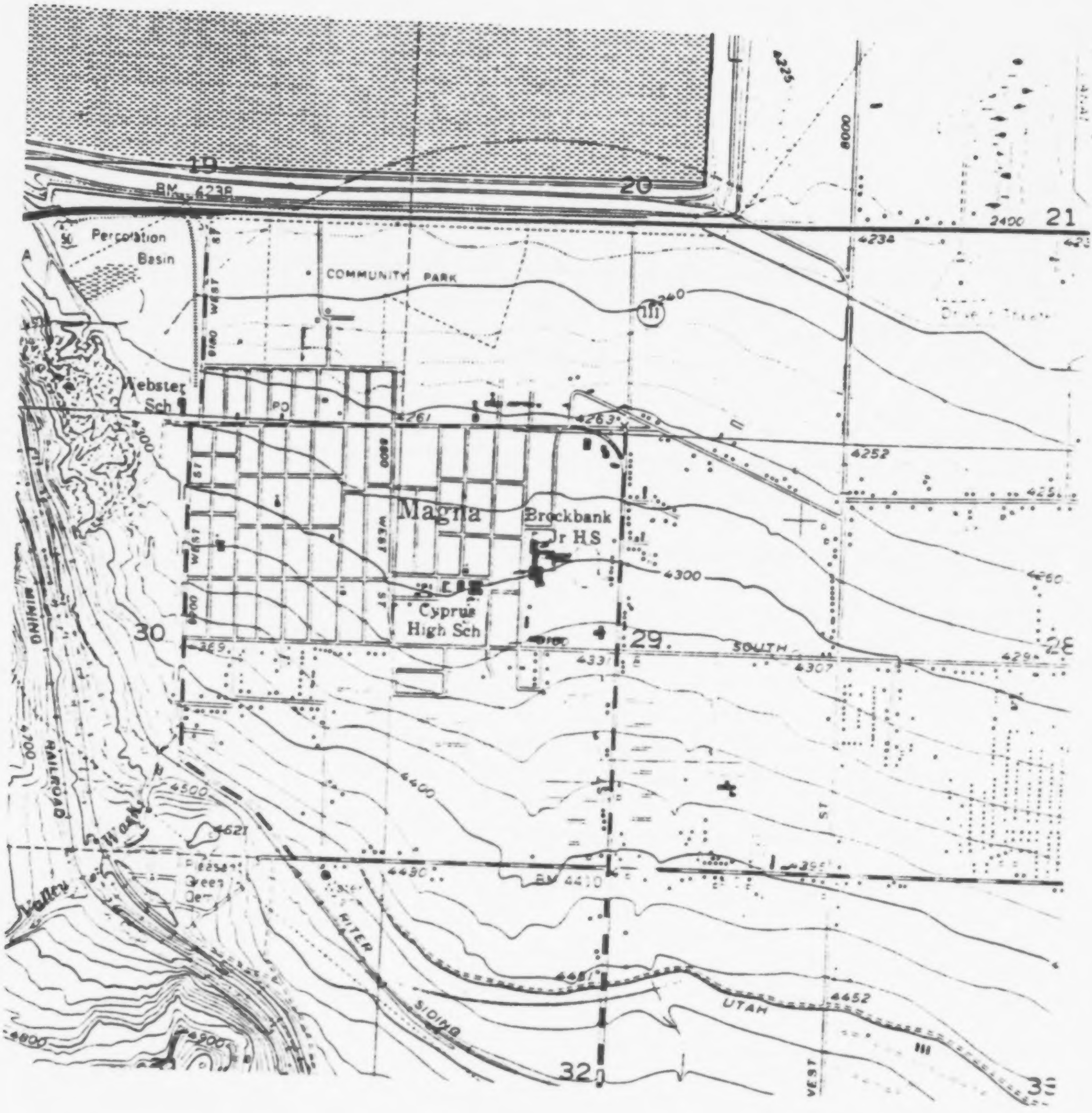
Topography - no special terrain

Localized sources, within 200 ft of monitor -

Source	Distance	Description
Paved parking	30 feet	North of site

Air quality data -

Monitor	Year	Annual arithmetic mean, μg/m³			No. of samples		
		TSP	IP	PM_{10}	TSP	IP	PM_{10}
F02	1982	52.2	0	0	12	0	0
F02	1983	55.1	0	0	56	0	0
A07	1980	87.0	0	0	28	0	0
A07	1981	69.0	44.0	0	45	24	0
A07	1982	53.6	30.2	0	32	25	0


19
20
21
BM 4238
4225
8000
2400
4234
Percolation Basin
COMMUNITY PARK
WEST ST
4240
111
Webster Sch
PO
4261
4263
4252
Magna
Brockbank Jr HS
WEST ST
4300
Cyprus High Sch
30
29
SOUTH
4307
4337
MINING
RAILROAD
4700
4400
4500
4621
Pleasant Green Cem
4430
BM 4410
MITER
SIDING
UTAH
4461
4452
4800
4900
32
ST
VEST

One mile radius around 2935 South, 8560 West, Magna, Utah. (Site 20)

AREA SOURCE SUMMARY (Site 20)

Site: Magna

Source category	Activity rate	TSP Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.3	0.2	0.2	0.2	0.2	0.9	0.9	0.9	0.9	4.7
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.4	0.4	2.1
Incinerators							0.1	0.1	0.1	0.1	0.4
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	31X10^{6}VMT	14.0	11.0	8.1	3.7	7.1	29.7	36.2	37.8	37.0	184.6
Unpaved rds/alleys	34X10^{3}VMT		0.2			0.1	19.4	4.4	4.4	20.3	48.8
Cleared areas	92 ac						11.3		13.5		24.8
Construction	13 ac			17.7			35.5	17.7	5.9		76.8
Agriculture	538 ac		4.1	7.2		5.9	99.1	54.1	45.1	27.0	242.5
Storage areas											
Unpaved pkg lots	5X10^{3}VMT		0.6			0.4				0.1	1.1

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.4	1.2	5.6	7.2
FUGITIVE DUST	14.0	66.1	498.5	578.6
Total	14.4	67.3	504.1	585.8

AREA SOURCE SUMMARY (Site 20)

Site: Magna

Source category	Activity rate	PM_{10} Emissions by sector, ton/yr									
		1	2	3	4	5	6	7	8	9	Total
COMBUSTION:											
Residential fuel		0.2	0.2	0.2	0.2	0.2	0.7	0.7	0.7	0.7	3.8
Comm/Ind fuel		0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.4	0.4	2.1
Incinerators							0.1	0.1	0.1	0.1	0.4
Rail/Air											
FUGITIVE DUST:											
Railroad yards											
Clean streets	$31X10^6$VMT	8.3	6.5	4.8	2.2	4.2	17.5	21.4	22.3	21.8	109.0
Unpaved rds/alleys	$34X10^3$VMT		0.1			0.1	10.9	2.5	2.5	11.4	27.5
Cleared areas	92 ac						5.8		6.9		12.7
Construction	13 ac			9.0			18.1	9.0	3.0		39.1
Agriculture	538 ac		1.8	3.2		2.7	44.6	24.3	20.3	12.2	109.1
Storage areas											
Unpaved pkg lots	$5X10^3$VMT		0.3			0.2				0.1	0.6

Recap	Emissions by sector, t/yr			
	1	2-5	6-9	Total
COMBUSTION	0.3	1.2	4.8	6.3
FUGITIVE DUST	8.3	35.1	254.6	298.0
Total	8.6	36.3	259.4	304.3

POINT SOURCE SUMMARY

Plant ID number	Plant name	Emission level, tons/yr		Distance from site, mi	Wind quadrant	UTM coordinates	
		TSP	PM_{10}			x	y
1	Hercules, Inc.	35	34	3.1	2	408.7	4501.7
2	Kennecott, Bonneville Mill	161	137	1.5	3	405.2	4506.3
3	Kennecott, Magna Mill	1721	1508	1.5	4	405.3	4507.3
4	Kennecott, Arthur Mill	48	41	2.5	4	403.7	4507.6
5	Kennecott, Garfield Refinery	35	30	3.7	4	401.9	4508.2

APPENDIX D

STEPWISE MULTIPLE LINEAR REGRESSION

Multiple linear regression (MLR) is a statistical technique for estimating expected values of a dependent variable, in this case particulate emission rates, in terms of corresponding values of two or more other (independent) variables. This technique uses the method of least squares to determine a linear prediction equation from a set of simultaneously obtained data points for all the variables. The equation is of the form:

$$\text{Concentration} = B_1x_1 + B_2x_2 + \ldots + B_nx_n + \text{constant}$$

where x_1 to x_n = concurrent quantitative values for each of the independent variables

B_1 to B_n = corresponding coefficients

The coefficients are estimates of the rate of change in emission rates produced by each variable. They can be determined easily by use of an MLR computer program or with a programmed calculator. Other outputs of the MLR program are:

1. A correlation matrix. It gives the simple correlation coefficients of all of the variables (dependent and independent) with one another. It is useful for identifying two interdependent (highly correlated--either positive or negative) variables (two variables that produce the same effect on emission rates), one of which should be eliminated from the analysis.

2. The multiple correlation coefficient (after addition of each independent variable to the equation). The square of the multiple correlation coefficient is the fraction of total variance in emission rates that is accounted for by the variables in the equation at that point.

3. Residual coefficient of variability. This is the standard deviation of the emission rates predicted by the equation (with the sample data set) divided by the mean of the

predicted emission rates, expressed as a percent. If a variable eliminates some sample variance, it will reduce the standard deviation and hence the relative coefficient of variability.

4. Significance of regression as a whole. This value is calculated from an F test by comparing the variance accounted for by the regression equation with the residual variance. A 0.05 significance level is a 1 in 20 chance of the correlation being due to random occurrence.

5. Significance of each variable. This is a measure of whether the coefficient (B) is different from 0, or that the relationship with the dependent variable is due to random occurrence. Variables that do not meet a prespecified significance level may be eliminated from the equation.

6. Constant in the equation.

The multiple correlation coefficient, unlike the simple correlation coefficient, is always positive and varies from 0 to 1.0. A value of zero indicates no correlation and 1.0 means that all sample points lie precisely on the regression plane. Because of random fluctuations in the data and inability to identify all the factors affecting concentrations, the multiple coefficient is almost never zero, even when there is no real correlation, and never 1.0, even when concentrations track known variables very closely. Therefore, it is important to test for statistical significance.

The form of MLR in the program used in this study was stepwise MLR. Variables were added to the equation in order of greatest increase in the multiple correlation coefficient, and the concentrations were then adjusted for that variable and regressed against the remaining variables again. The procedure can be ended by specifying a maximum number of variables or a minimum F value in the significance test.

A statistically significant regression relationship between independent variables and concentration is no indication that the independent variables cause the observed changes in concentration, as both may be caused by a neglected third variable.

APPENDIX E

DESCRIPTION OF EMPIRICAL PARTICULATE MODEL

The empirical particulate model represents an approach to quantifying the relationship between particulate emissions and ambient concentrations. It was developed primarily by EPA, and is based on the correlation previously observed between measured particulate concentrations and emission density within a 1-mile radius surrounding the sampler. The technique for inventorying particulate sources within this area has evolved to its present state over a period of about 6 years. The technique, commonly referred to as a microinventory, is described in detail in Appendix A.

FORM OF EMPIRICAL MODEL

The form of the model is a multiple linear regression equation with annual geometric mean particulate concentration as the dependent variable and seven independent variable terms. The independent variables are annual area source emissions within 1 mile, annual point source emissions within 5 miles, local sources (particularly traffic-related), presence of dirt on the nearest street, and three city-specific adjustments to the background concentration. These variables were determined by screening approximately 30 potential variables by simple linear regression and selecting the independent ones with the highest partial correlations. Stepwise multiple regression was then employed to derive the coefficients for each of the terms in the equation and to obtain the statistical values used to judge the accuracy of the regression equation.

The data base for developing the model was generated at 79 sites in four cities. Each site had measured concentrations, microinventory results, and other information such as surrounding land use and distances to the sources. The multiple correlation (R) with the seven variables was 0.876, based on the use of all 79 data sets; none was eliminated as outliers. Therefore, the seven variables explained 0.767 of the variance (R^2) in measured concentrations.

The resulting general equation is as follows:

$$\begin{aligned}\text{AVGAQ} = {} & 0.00451(\text{AREA}) + 0.00096(\text{POINT}) + \\ & 50.5(\text{LOCAL}) + 18.6(\text{VISDT}) + \\ & (\text{DPT, DSC, DB, or O}) + 57.2\end{aligned}$$

where AVGAQ = Predicted annual geometric mean, mg/m³

$$\text{AREA} = \left(\frac{A_1}{0.0324}\right)\left(\frac{25}{\text{HGT}}\right) + \left(\frac{A_{2-5}}{0.16}\right) + \left(\frac{A_{6-9}}{0.6084}\right)$$

A_i = Total area source emissions in sector i, ton/yr (i = 1 to 9)

HGT = Height of sampler, ft

$$\text{POINT} = \sum_{i-1}^{n} \frac{\text{PSEM}_i}{D_i^{\,2}} (\text{WWF})$$

n = Number of point sources within 5 mi

PSEM_i = Emissions from point source i, ton/yr

D_i = Distance to point source i, mi (lower limit of D_i if 0.25)

WWF = Wind weighting factor computed as wind frequency (%) in quadrant where source is located divided by 25, dimensionless. (The frequency of winds was determined from NWS data taken at the nearest station or a compilation of the two nearest stations' data.)

$$\text{LOCAL} = \frac{\ln \text{ADT}_1}{\sqrt{\text{HGT}^2+\text{DIS}_1^{\,2}}} + \frac{\ln \text{ADT}_2}{\sqrt{\text{HGT}^2+\text{DIS}_2^{\,2}}}$$

ADT_i = Average daily traffic on nearby road i, veh/day

DIS_i = Distance to road i, ft (upper limit of DIS_i is 200)

VISDT = 0 if no visible plume results from passing traffic, 1 if there is a plume

DPT, DSL, DB = Dummy variables to account for different background concentrations in each of the cities relative to Kansas City:
DPT = -21.6 (Portland), DSL = -6.6 (St. Louis), DB = -6.9 (Birmingham)

Corresponding multiple regression equations with different coefficients and only four variables can be developed by using the smaller data set from any one city. For example, the equation derived with just the 32 Kansas City sites would be:

$$\text{AVGKC} = 0.0054(\text{AREA}) + 0.00057(\text{POINT}) + 55.2(\text{LOCAL}) + 10.6(\text{VISDT}) + 57.6$$

The equation using the 23 St. Louis sites would be:

$$\text{AVGSL} = 0.0019(\text{AREA}) + 0.0020(\text{POINT}) + 45.9(\text{LOCAL}) + 25.0(\text{VISDT}) + 56.0$$

EVALUATION OF MODEL

Three independent evaluations of the model were performed: one from the statistics provided by the stepwise multiple regression program, the second by testing stability of the coefficient, and the third by testing the model's predictions with data from 32 additional sites in three other cities.

The summary statistics from the stepwise multiple regression analysis with 79 data sets are presented in Table E-1. Prior to the regression analysis, a correlation matrix was prepared to determine whether intercorrelations between any of the variables could bias the results. The variables were all found to be independent. The F test was used to determine whether each of the individual variables was significant. The critical F value of 2.87 at the 99 percent level for seven variables and 79 observations, compared with the F values in Table E-1, indicated that all the variables except the city-specific adjustments to background were highly significant.

The standard errors for the variable coefficients were (again, with the exception of the city-specific variables) only about 20 percent of the coefficient values. The standard error of the regression equation was 13.6 $\mu g/m^3$, about 17 percent of the average measured concentration. The relative errors for all but 3 of the 79 predicted concentrations were less than 28 percent. It should be emphasized again that none of the data sets from the four cities was removed before performing the regression analysis, although some were suspected to contain anomalies.

TABLE E-1. SUMMARY OF STEPWISE MULTIPLE REGRESSION ANALYSIS

Variable[a]	Multiple correlation[b]	Regression coefficient	Std error of regression coefficient	Computer F value	Cumulative proportion of sum of squares reduced (R^2)
AREA	0.617	0.00451	0.00082	30.4	0.381
POINT	0.761	0.00096	0.00014	45.7	0.579
DPT	0.813	-21.6	4.9	18.9	0.660
LOCAL	0.838	50.5	12.0	17.6	0.703
VISDT	0.869	18.6	4.9	14.6	0.756
DSL	0.873	-6.6	4.0	2.8	0.761
DB	0.876	-6.9	5.4	1.7	0.767
Intercept		57.2			

[a] In order of selection by regression program.
[b] Adjusted for degrees of freedom.

The stability or sensitivity of coefficients in the equation was tested by running two additional regression analyses, each with 75 percent of the sites (selected at random) from the initial analysis. The AREA and POINT coefficients were found to be very stable, the LOCAL coefficient fairly stable, and the VISDT coefficient fairly sensitive to the specific sites included and excluded. It was determined that a few influential sites could affect the VISDT coefficient by as much as 15 percent.

Comparison of model-predicted and measured concentrations at 28 additional sites in three cities showed that, with consideration of city-specific background concentrations, the predicted values were quite good:

City	No. of sites	r	r^2	Slope	Intercept
Philadelphia	10	0.95	0.90	1.16	-12.7
Pittsburgh	7	0.94	0.88	1.21	-19.9
Boston-Worchester	11	0.93	0.86	1.03	-6.5

If linear regression for a particular area yields a good correlation but the model consistently over- or underpredicts concentrations, the accuracy of the predictions can be improved by calculating the variable (e.g., DPT, DSL, DB) for the area being analyzed.

This variable is simply the average residual for the samplers in the study area. The average residual is readily computed with the equation:

$$R = \sum_{i=1}^{n} \frac{MC_i - PC_i}{n}$$

where R = average residual
MC_i = measured concentration at site i, μg/m³
PC_i = predicted concentration at site i, μg/m³
n = number of samplers

The average residual is, effectively, a correction to the 57.2 constant term in the general form of the empirical model.

APPLICATION OF MODEL

The empirical model is only moderately data-intensive. It can be used for particulate air quality analyses ranging from neighborhood to regional scales. The primary purpose of the model is to estimate the relative impact of different sources and source categories on ambient concentrations. It cannot properly be used to predict concentrations at specified locations in areas other than those for which it is specifically developed, because of its means of derivation and the magnitude of the standard error associated with the regression equation. It is very useful in interpreting microinventory data by estimating the relative impacts of various sources and source categories at specific sites in other areas.

At each site, the measured concentration provides a check on the accuracy of the model's prediction. The only limitation to this self-validating feature is that several sites in a city must be microinventoried to obtain the city-specific background adjustment before the model can yield its best prediction. For the purpose of this study the background levels were estimated from data for the nearest rural or background site.